THE
OCULIST'S
VADE
MECUM

# The Oculist's Vade Mecum.

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Comprising all the important methods of testing the eyes, which have been devised by leading ophthalmic surgeons of Philadelphia; besides many valuable tables on the properties of lenses and methods of procedure in the examination of the eyes.

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# PREFACE.

The aim of this work has been to present a System of test types for the examination of the eye of such accuracy in their construction that the Oculist might confidently rely upon them in the determination of the refraction and accommodation of the eye. Reading matter for testing the eyes should be so arranged as to accomplish two purposes: The first of these is the determination of the amplitude of the accommodation, and is effected by having types of the sizes that represent normal visual acuity, as the distance of the near point varies with age. Unless the type is small enough to represent normal visual acuity on the near point designated, the real near point may be at some distance beyond. Thus we understand that a vision of $\frac{6}{12}$ say in a presbyope represents a hypermetropia of 1 or 2 dioptries; similarly a near point of 25 centimetres, which represents 4 dioptries of accommodation if obtained by type representing normal vison at 50 centimetres would have a visual acuity of $\frac{25}{50}$, and as that is compatible with a lack of 1 or 2 dioptries of accommodation, instead of 4 we might have 3, or even 2 dioptries of accommodation if the visual acuity is high. With 25 centimetres, type constructed on an angle of 5′, the error in measuring the accommodation is very much reduced. To still further remove the difficulty, type is introduced that represents at 15 centimetres an angle of 5′. A visual acuity of $\frac{5}{3}$ is very common, so that a person with $\frac{5}{3}$ visual acuity and 4 dioptries of accommodation ought still to read this type at 25 centimetres. It is, however, for people below the age of 30 that such type will be most useful, and may lead to a rearrangement of the amplitude of accommodation. The second purpose to be fulfilled in reading matter as test type is the selection of glasses which will be most comfortable at the distance which the patient prefers holding the book. There is a small margin in which the preference of the indi-

vidual must be recognized in order to give complete satisfaction. For this purpose one full page of the book is printed in English type of the size that is commonly found in newspapers and magazines. Too small type is apt to mislead the patient into selecting a stronger glass than is necessary.

The dispensary services of all the large hospitals have a considerable number of foreigners among their patients, who are mainly Germans, Italians and Hebrews. Many of them are unable to read English, and a difficulty arises on this account, in furnishing them with glasses. To obviate this, types of German, Italian and Hebrew (dialect) have been added to the English. It is hoped that these will be found convenient, especially for patients who have had their sight restored after cataract operation, who can be tested at first in their own room, if necessary.

The types are evenly graded, accurately measured and clearly printed on heavy glazed paper, so that in the smaller types due value is given to the finest details.

The types have their distances marked above them at which they represent normal visual acuity. For convenience of all, the distances are denoted both in centimetres and in English inches, and a table is appended of the amplitude of accommodation and the near point of different ages.

The great importance of testing the action of the ocular muscles is well recognized, and this work is greatly indebted for methods of testing the muscles as well as descriptive papers on the subject to Drs. Risley, Jackson, Hansell and Ziegler. Dr. Harlan has contributed a valuable paper on Toric lenses; Drs. Stevens, Thorington and Carpenter have furnished papers that will be a great help in refraction technique; finally, acknowledgment is made of Dr. Posey's practical paper on testing for simulated monocular blindness, and Dr. Zimmerman's lamp screen. Many valuable tables, some of them original in this work, have been introduced with the view of collecting together every needful adjunct in the examination of the eyes. It is hoped that a large amount of useful information that is usually only to be found scattered through text books has been gathered here where it can be most easily utilized as a work of reference.

# TABLE OF CONTENTS.

# Table of the amplitude of the accommodation and the near point of the eye at different ages.

| AGE. | Amplitude of Accommodation in Dioptres | NEAR POINT. | |
| --- | --- | --- | --- |
| | | CENTIMETRES | INCHES |
| 10 | 14 | 7 | 2.75 |
| 15 | 12 | 8.5 | 3.25 |
| 20 | 10 | 10 | 3.87 |
| 25 | 8.5 | 12 | 4.75 |
| 30 | 7 | 14 | 5.5 |
| 35 | 5.5 | 18 | 7 |
| 40 | 4.5 | 22 | 8.62 |
| 45 | 3.5 | 28 | 11 |
| 50 | 2.5 | 40 | 15.75 |
| 55 | 1.75 | 57 | 22.37 |
| 60 | 1 | 100 | 40 |
| 65 | .50 | 200 | 80 |
| 70 | .25 | 400 | 160 |
| 75 | Infinite. | Infinite. | Infinite. |

.15

.25

.37 M.

portions of the great bene-
fits which Helmholtz has
conferred upon the scien-
tific world. The verifi-
cation of this mechanism
has been supplied by Hen-
sen and Volckers by prov-
ing indisputably the for-
ward movement of the
choroid. In considering
the delicacy of movement
necessary to sharply focus
upon the retina the image
formed by a system of
lenses whose equivalent
focus is 15 millimetres,
whose integral parts are

.50 M

not always well centred,
whose errors of refraction
not infrequently include a
considerable degree of as-
tigmatism, and whose ac-
tion is automatic, we are
justified in asking whether
there is not some common
bond between retina, cili-
ary muscle, and crystalline
lens, by which the amount
of nerve force exerted is
always proportioned to the
degree of the error and
within certain limits modi-
fied by its character ? It

.75 M

is no unusual
thing to find an
astigmatism of
from .5 to 1 di-
optre obliterated
by the accommo-
dation. We might
also add here that
the permanency
of the accommo-

1 M

dation for a
fixed distance
during several
c o n s e c u t i v e
hours, without
any sensible ef-
fort o n o u r
part, a r g u e s

**These Types represent normal visual acuity when read at the distances marked above them.**

## 37 CENTIMETRES OR 15 INCHES.

Another bright day shining in through the small casement, and claiming fellowship with the kindred eyes of the child, awoke her. At sight of the strange room and its unaccustomed objects she started up in alarm, wondering how she had been moved from the familiar chamber in which she seemed to have fallen asleep last night, and whither she had been conveyed. But another glance around recalled to her mind all that had lately passed, and she sprang from her bed, hoping and trustful. It was yet early, and the old man being still asleep, she walked out into the church-yard, brushing the dew from the long grass with her feet, and often turning aside into places where it grew longer than in others, that she might not tread upon the graves. She felt a curious kind of pleasure in lingering among these houses of the dead, and read the inscriptions on the tombs of the good people (a great number of good people were buried there), passing on from one to another with increasing interest. It was a very quiet place, as such a place should be, save for the cawing of the rooks who had built their nests among the branches of some tall old trees, and were calling to one another, high up in the air. First, one sleek bird, hovering near his ragged house as it swung and dangled in the wind, uttered his hoarse cry, quite by chance as it would seem, and in a sober tone, as though he were but taking up himself. Another answered, and he called again, but louder than before; then another spoke, and then another; and each time the first, aggravated by contradiction, insisted on his case more strongly. Other voices, silent till now, struck in from boughs lower down and higher up and midway, and to the right and left, and from the tree-tops; and others, arriving hastily from the gray church turrets and old belfry windows, joined the clamor which rose and fell, and swelled and dropped again, and still went on; and all this noisy contention amid a skimming to and fro, and lighting on fresh branches, and frequent change of place, which satisfied the restlessness of those who lay so still beneath the moss and turf below, and the strife in whose very had worn away their lives. Frequently raising her eyes to the trees whence these sounds came down, and feeling as though they made the place more quiet than perfect silence would have done, the child loitered from grave to grave, now stopping to replace with careful hands the bramble which had started from some green mound it helped to keep in shape, and now peeping through one of the low latticed windows into the church, with its worm-eaten books upon the desks, and baize of mouldering green mouldering from the pew-sides and leaving the naked wood to view. There were the seats where the poor old people sat, worn spare and yellow like themselves; the rugged font where the like had their names, the homely altar where they knelt in after-life, the plain black tressels that bore their weight on their last visit to the cool old shady church. Everything told

## 50 CENTIMETRES OR 20 INCHES.

She was looking at an humble stone which told of a young man who had died at twenty-three years old, fifty-five years ago, when she heard a faltering step approaching, and looking around saw a feeble woman bent with the weight of years, who tottered to the foot of that same grave and asked her to read the writing on the stone. The old woman thanked her when she had done, saying that she had had the words by heart for many a long, long year, but could not see them now. "Were you his mother?" said the child. "I was his wife, my dear." She the wife of a young man three-and-twenty? Ah, true! It was fifty-five years ago. "You wonder to hear me say that," remarked the old woman, shaking her head. "You're not the first. Older folk than you have wondered at the same thing before now. Yes, I was his wife. Death doesn't change us more than life, my dear." "Do you come here often?" asked the child. "I sit here very often in the summer-time," she answered. "I used to come here once to cry and mourn; but that was a weary while ago, bless God! I pluck the daisies as they grow, and take them home," said the old woman, after a short silence. "I like no flowers so well as these, and haven't for five-and-fifty years. It's a long time, and I'm getting very old." Then, growing garrulous upon a theme which was new to one listener, though it were but a child, she told her how she had wept and moaned and prayed to die herself when this happened, and how, when she first came to that place, a young creature strong in love and grief, she had hoped that her heart was breaking, as it seemed to be. But that time passed by, and although she continued to be sad when she came there, still she could bear to come, and so went on until it was pain no longer, but a solemn pleasure, and a duty she had learned to like. And now that five-and-fifty years were gone, she spoke of the dead man as if he had been her son or grandson, with a kind of pity for his youth, growing out of her own old age, and an exalting of his strength and manly beauty as compared with her own weakness and decay; and yet she spoke about him as her husband, too, and thinking of herself in connection with him, as she use to be, and not as she was now; talked of their meeting in another world, as if he were dead but yesterday, and she, separated from her former self, were thinking of the happiness of that comely girl who seemed to have died with him. The child left her gathering the flowers that grew upon the grave, and thoughtfully retraced her steps. The old man was by this time up and dressed. Mr. Codlin, still doomed to contemplate the harsh realities of existence, was packing among his linen

## 62 CENTIMETRES OR 25 INCHES.

"Objection," said the little man. "Now be gracious for once, Tommy, and say that you'd rather they went with us. I know you would. Be gracious Tommy. "Trotters!" said Mr. Codlin who talked and eat very greedily, as is not uncommon with philosophers and misanthropes; "your're too free." "Why, what harm can it do?" urged the other. "No harm at all in this particular case, perhaps," replied Mr. Codlin; "but the principle's a dangerous one, and you're too free, I tell you." "Well, here they to go with us or not?" "Yes, they are," said Mr. Codlin; "but you might have made a favor of it, mightn't you?" The real name of the little man was Harris, but it gradually merged into the less euphonious one of Trotters which, with the prefatory adjective Short, had been conferred upon him by reason of the small size of his legs. Short Trotters, however, being a compound name, inconvenient for use in friendly dialogue, the gentleman on whom it had been bestowed was known among his intimate friends as "Short ' or "Trotters," and was seldom accosted at full length as Short Trotters, except in formal conversations and on occasions of ceremony. Short, then, or Trotters, as the reader pleases, replied unto the remonstrance of his friend Mr. Thomas Codlin a jocose answer calculated to turn aside his discontent; and applying himself with great relish to the cold boiled beef, the tea, and bread and butter, strongly impressed upon his companions that they should do the like. Mr. Codlin, indeed, required no such persuasion, as he had already eaten as much as he could possibly carry and was now moistening his clay with strong ale, whereof he took deep draughts with a silent relish and invited nobody to partake—thus again strongly indicating his misanthropical turn of mind. Breakfast being at length over, Mr. Codlin called for the bill, and charging the ale to the company generally (a practice also savoring of misanthropy), divided the sum-total into two fair and equal parts, assigning one moiety to himself and friend and the other to Nelly and her grandfather. These being duly discharged, and all things ready for their departure, they took farewell of the landlord and landlady and resumed their journey. And here Mr. Codlin's false position in society and the effect it wrought upon his wounded spirit,

## 75 CENTIMETRES OR 30 INCHES.

Sometimes they played out the toll across a bridge or ferry, and once exhibited, by particular desire, a turnpike, where the collector, being drunk in his solitude, paid down a shilling to have it to himself. There was one small place of rich promise in which their hopes were blighted, for a favorite character in the play having gold lace upon his coat and being a meddling, wooden-headed fellow, was held to be a libel on the beadle, for which reason the authorities enforced a quick retreat; but they were generally well received, and seldom left a town without a troop of ragged children shouting at their heels. They made a long day's journey, despite these interruptions, and were yet upon the road when the moon was shining in the sky. Short beguiled the time with songs and jests, and made the best of everything that happened. Mr. Codlin, on the other hand, cursed his fate and all the hollow things of earth (but Punch especially), and limped along with the theatre on his back, a prey to the bitterest chagrin. They had stopped to rest beneath a finger-post where four roads met, and Mr. Codlin in his deep misanthropy had let down the drapery and seated himself in the bottom of the show, invisible to mortal eyes and disdainful of the company of his fellow-creatures, when two monstrous shadows were seen stalking towards them from a turning in the road by which they had come. The child was at first quite terrified by the sight of these gaunt giants—for such they looked as they advanced with lofty strides beneath the shadows of the trees—but telling her there was nothing to fear, blew a blast upon the trumpet, which was answered by a cheerful shout. "It's Grinder's lot, ain't it?" cried Mr. Short, in a loud key. "Yes," cried a couple of shrill voices. "Come on then," said Short. "Let's have a look at you. I thought it was you." Thus invited. "Grinder's lot" approached with redoubled speed, and soon came up with the little party. Mr. Grinder's company, familiarly termed a lot, consisted of a young gentleman and a young lady on stilts, and Mr. Grinder himself, who used his natural legs for pedestrian purposes and carried at his back a drum. The public costume of

the young people was of the Highland kind, but the night being damp and cold, the young gentleman wore over his kilt a man's pea-jacket reaching to his ankles, and a glazed hat; the young lady too was muffled in an old cloth pelisse and had a handkerchief tied about her head. Their Scotch bonnets, ornamented with plumes of jet-black feathers, Mr. Grinder carried on his instrument. "Bound for the races, I see," said Mr Grinder, coming up out of breath. "So are we. How are you, Short?" With that they shook hands in a very friendly manner. The young people, being too high up for the ordinary salutations, saluted Short after their own fashion. The young gentleman twisted up his right stilt and patted him on the shoulder,

and the young lady rattled her tambourine. "Practice?" said Short, pointing to the stilts. "No," returned Grinder. "It comes either to walkin' in 'em or carryin' of 'em, and they like walkin' in 'em best. It's weary pleasant for the prospects. Which road are you takin'? We go the nighest." "Why, the fact is," said Short, "that we are going the longest way, because then we could stop for the night a mile and a half on. But three or four mile gained to-night is so many saved to-morrow, and if you keep on, I think our best way is to do the same." "Where's your partner, inquired Grinder. "Here he

The child considered for a moment, and reflecting that she must shortly beg, and could scarcely hope to do so at a better place than where crowds of rich ladies and gentlemen were assembled together for purposes of enjoyment and festivity, determined to accompany these men so far. She therefore thanked the little man for his offer, and said, glancing timidly toward his friend, that if there was no objection to their accompanying them as far as the race town

Cried Mr. Thomas Codlin. presenting his head and face in the proscenium of the stage and exhibiting an expression of countenance not often seen

5 METRES OR 200 INCHES.

there; and he will see his partner boiled alive before

6 METRES OR 240 INCHES.

LITTLE NELL AND THE MARCHIONESS, MRS. JARLEY'S WAX WORKS, DICK SWIV-

ANOTHER bright day was shining in through the small casement, and claiming fellowship with the kindred eyes of the child, awoke her. At sight of the strange room and its unaccustomed objects she started up in alarm, wondering how she had been moved from the familiar chamber in which she seemed to have fallen asleep last night, and whither she had been conveyed. But another glance around called to her mind all that had lately passed, and she sprung from her bed, hoping and trustful.

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"Were you his mother?" said the child.

"I was his wife, my dear."

She the wife of a young man three-and-twenty! Ah, true! It was fifty-five years ago.

"Do you wonder to hear me say that," remarked the old woman, shaking her head. "You're not the first. Older folk than you have wondered at the same thing before now. Yes, I was his wife. Death doesn't change more than life, my dear."

"Do you come here often?" asked the child.

"I sit here very often in the summer-time," she answered. "I used to come here once to cry and moan, but that was a weary while ago, bless God!"

Endlich kam die Zeit herbei, da man sich zur Ueberfahrt schicken, die Kutschen und Wagen erwarten sollte, die unsere ganze Truppe nach dem Schlosse des Grafen hinüber zu führen bestellt waren. Schon zum voraus fielen große Streitigkeiten vor, wer mit dem andern fahren, wie man sitzen solle? Die Ordnung und Einteilung ward endlich nur mit Mühe ausgemacht und festgesetzt, doch leider ohne Wirkung. Zur bestimmten Stunde kamen weniger Wagen, als man erwartet hatte, und man mußte sich einrichten. Der Baron, der zu Pferde nicht lange hinterdrein folgte, gab zur Ursache an: daß im Schlosse alles in großer Bewegung sei, weil nicht allein der Fürst einige Tage früher eintreffen werde, als man geglaubt, sondern weil auch unerwarteter Besuch schon gegenwärtig angelangt sei; der Platz gehe sehr zusammen, sie würden auch deswegen nicht so gut logieren, als man es ihnen vorher bestimmt habe, welches ihm außerordentlich leid thue. Man teilte sich in die Wagen, so gut es gehen wollte, und da leidlich Wetter und das Schloß nur einige Stunden entfernt war, machten sich die Lustigsten lieber zu Fuße auf den Weg, als daß sie die Rückkehr der Kutschen hätten abwarten sollen. Die Karawane zog mit Freudengeschrei aus, zum erstenmal ohne Sorgen, wie der Wirt zu bezahlen sei. Das Schloß des Grafen stand ihnen wie ein Feengebäude vor der Seele; sie waren die glücklichsten und fröhlichsten Menschen von der Welt, und jeder knüpfte unterwegs an diesen Tag, nach seiner Art zu denken, eine Reihe von Glück, Ehre und Wohlstand. Ein starker Regen, der unerwartet einfiel, konnte sie nicht aus diesen angenehmen Empfindungen reißen; da er aber immer anhaltender und stärker wurde, spürten viele von ihnen eine ziemliche Unbequemlichkeit. Die Nacht kam herbei, und erwünschter konnte ihnen nichts erscheinen, als der durch alle Stockwerke erleuchtete Palast des Grafen, der ihnen von einem Hügel entgegen glänzte, so daß sie die Fenster zählen konnten. Als sie näher heran kamen, fanden sie auch alle Fenster der Seitengebäude erhellet. Ein jeder dachte bei sich, welches wohl sein Zimmer werden möchte? und die meisten begnügten sich bescheiden mit einer Stube in der Mansarde oder den Flügeln. Nun fuhren sie durch das Dorf und am Wirtshause vorbei. Wilhelm ließ halten, um dort abzusteigen; allein der Wirt versicherte, daß er ihm nicht den geringsten Raum anweisen könne. Der Herr Graf habe, weil unerwartete Gäste angekommen, sogleich das ganze Wirtshaus besprochen, an allen Zimmern stehe schon seit gestern mit Kreide deutlich angeschrieben, wer darinne

wohnen solle. Wider seinen Willen mußte also unser Freund mit der übrigen Gesellschaft zum Schloßhofe hineinfahren. Um die Küchenfeuer in einem Seitengebäude sahen sie geschäftige Köche sich hin und her bewegen und waren durch diesen Anblick schon erquickt; eilig kamen Bediente mit Lichtern auf die Treppe des Hauptgebäudes gesprungen, und das Herz der guten Wanderer quoll über diesen Aussichten auf. Wie sehr verwunderten sie sich dagegen, als sich dieser Empfang in ein entsetzliches Fluchen auflöste. Die Bedienten schimpften auf die Fuhrleute, daß sie hier hereingefahren seien; sie sollten umwenden, rief man, und wieder hinaus nach dem alten Schlosse zu, hier sei kein Raum für diese Gäste! Einem so unfreundlichen und unerwarteten Bescheide fügten sie noch allerlei Spöttereien hinzu und lachten sich unter einander aus, daß sie durch diesen Irrtum in den Regen gesprengt worden. Es goß noch immer, keine Sterne standen am Himmel, und nun wurde die Gesellschaft durch einen holprichten Weg zwischen zwei Mauern in das alte hintere Schloß gezogen, welches unbewohnt da stand, seit der Vater des Grafen das vordere gebaut hatte. Teils im Hofe, teils unter einem langen gewölbten Thorwege hielten die Wagen still, und die Fuhrleute, Anspanner aus dem Dorfe, spannten aus und ritten ihrer Wege. Da Niemand zum Empfange der Gesellschaft sich zeigte, stiegen sie aus, riefen, suchten vergebens! Alles blieb finster und stille. Der Wind blies durch das hohe Thor, und graurlich waren die alten Türme und Höfe, wovon sie kaum die Gestalten in der Finsternis unterschieden. Sie froren und schauerten, die Frauen fürchteten sich, die Kinder fingen an zu weinen; ihre Ungeduld vermehrte sich mit jedem Augenblicke, und ein so schneller Glückswechsel, auf den niemand vorbereitet war, brachte sie alle ganz und gar aus der Fassung. Da sie jeden Augenblick erwarteten, daß jemand kommen und ihnen aufschließen werde, da bald Regen, bald Sturm sie täuschte und sie mehr als einmal den Tritt des erwünschten Schloßvogts zu hören

glaubten, blieben sie eine lange Zeit unmutig und unthätig; es fiel keinem ein, in das neue Schloß zu gehen und dort mitleidige Seelen um Hilfe anzurufen. Sie konnten nicht begreifen, wo ihr Freund, der Baron, geblieben sei, und waren in einer höchst beschwerlichen Lage. Endlich kamen wirklich Menschen an, und man erkannte an ihren Stimmen jene Fußgänger, die auf dem Wege hinter den Fahrenden zurück geblieben waren. Sie erzählten, daß der Baron mit dem Pferde gestürzt sei, sich am Fuße stark beschädigt habe und daß man auch sie, da sie im Schlosse nachgefragt, mit Ungestüm hierher gewiesen habe. Die ganze Gesellschaft war in der größten Verlegenheit; man ratschlagte, was man thun sollte und konnte keinen Entschluß fassen. Endlich sah man von weitem eine Laterne kommen und holte frischen Atem; allein die Hoffnung einer baldigen Erlösung verschwand auch wieder, indem die Erscheinung näher kam und deutlich ward. Ein Reitknecht leuchtete dem bekannten Stall=

meister des Grafen vor, und dieser erkundigte sich, als er näher kam, sehr eifrig nach Mademoiselle Philinen. Sie war kaum aus dem übrigen Haufen hervorgetreten, als er ihr sehr dringend anbot, sie in das neue Schloß zu führen, wo ein Plätzchen für sie bei den Kammerjungfern der Gräfin bereitet sei. Sie besann sich nicht lange, das Anerbieten dankbar zu ergreifen, faßte ihn bei dem Arme und wollte, da sie den anderen ihren Koffer empfohlen, mit ihm

3 METRES OR 120 INCHES.

forteilen; allein man trat ihnen in den Weg, fragte, bat, be= schwor den Stallmeister, daß er endlich, um nur mit seiner Schö= nen loszukommen, alles versprach

5 METRES OR 200 INCHES.

und versicherte, in kurzem solle das Schloß eröffnet und sie auf das beste ein= quartiert werden. Gleich

Il seguente fatto avvenuto in casa Cènci, innanzi che egli partisse per Rocca Petrella, farà conoscere di più l' offerato cuore di costui. — Beatrice stava seduta sopra un verone delopalazzo Cenci, che guardava il giardino; in grembo ella teneva un fanciullo, e dagli occhi, da' capelli, da tutte le sue sembianze appariva esserle fratello; ella gli accarezzava amorosa la chioma, ed a tratto in tratto gli baciava la fronte. Il fanciullo riposa il suo capo sul seno della sorella, ed affissa in lei le pupille immote, ma senz'intenzione, a guisa di persona assorta nel pensiero di qualche cosa fuori di questo mondo. La infermità aveva appassito il fiore della giovinezza; la sua pelle era tenue e candida di un bianco pallido e delicato così, che i raggi del sole cadenti gli traducevano in vermiglio traversole orecchie e le dita, talora sospirava, più spesso schiudeva la bocca con ischadiglio convulso: pareva un angelo in pena. Beatrice, sconголando, gli disse: — A che pensi, mio diletto Virgilio? — Penso che sarebbe pure stata la grande carità non farei mai venire al mondo! — Ah! Virgilio. . . . — E poiche a questo non trovo più rimedio, il meglio sarà uscirne presto. — l'uscirne! E perche? E perche? E perche restarci? Il mio cuore qui dentro è morto da tempo; e quando il cuore è morto, oh come pesa che gli sopravviva il corpo! — Tu, si può dire, tiaffacci appena, fratello, alla vita, e gia favelli parole disperate; ciò non ista bene; vivi e rallegrati, perche non sai quali rose educhi per la fortuna. — Rose! fortuna! Adesso la morte coglie i fiori per la ghirlanda della mia bara. La fortuna ci mostra visere di madre. . . . — Ma noi non ci possiamo considerare orfani affatto: forse l'ottima signora Lucrezia non ci mostra visere di madre? — Si, ma non è nostra madre. — E poi non hai anche me, che ti amo tanto ? — Si, si, buona sorella, risponde il fanciullo, gittandole le braccia al collo e piangendo dirotto; ma ne anche tu sei la mamma mia. — Ed oltre a me, ti mancano forse fratelli? Non hai tu padre? — Chi padre? — Beatrice, atterrita dall'improvviso rimescolarsi del fanciullo a cotesta parola, si tacque. Solo, dopo lungo silenzio, con voce esitante soggiunse: — Francesco Cenci non è per avventura tuo padre. . . . e mio? — Il fanciullo abbassò il capo, chiuse gli occhi, fece delle braccia al petto croce, e con suono velato rispose: — Sorella, guardami sulla fronte alla radice de' capelli; vedi la cicatrice che vi porto? — Lo vedi? Sai tu chi mi ha ferito? — Io non lo dissi, fin qui, ma ora che mi sento vicino a morire, io te lo posso confessare. Ripensando fra me come Francesco Cenci mi tenesse in dispregio, e sovente mi guardasse di traverso, a me parendo meritarlo, un giorno, fattomi cuore, gli caddi davanti e tentai prendergli la mano per recarmela alla bocca. Egli gridò: "Va' via, bastardo!" e mi diè così forte un pugno nel petto, che mi spinse giù a precipizio a percotere col capo nell'angolo dell'armario, ch'ei tiene nel suo studio. — Francesco Cenci mi vide avvenuto e tutto intriso di sangue; mi vide, e non mi rilevò. — Di qui la ferita, di qui la infermità, che mi consuma le viscere. . . . — Guarda la traccia di questo morso. Sai tu chi me l' ha fatto? Nerone del filo cane di Francesco Cenci, e senti come. Un giorno io colsi in giardino una bella pesca, e dissi: Andiamo ad offrirla al signor padre, che forse la gradiva. In questo pensiero mi avvio alla sua stanza per l'uscio, e vedo ch'ei legge. Timoroso di disturbarlo, mi accosto pian piano, quando Nerone mi si avventa addosso e mi morde il braccio. Io spasimava pel dolore. . . . mio padre rideva. Il seno di Beatrice palpitava così, che pareva volesse spezzarsi — E se Marzio non era, egli mi

Fatti i debiti onori di sepoltura al cadavere del conte Cènci, la famiglia torno a Roma, ed a Rocca Petrella non si penso più al Cenci e al modo con cui era perito. Ma era in Roma un personaggio, che poteva aver interesse a svelare il mistero della morte del Cènci, e questi era un Colonna, che ne appetiva il patrimonio. Egli tenne dietro ai due famigliari partecipi dei segreti di famiglia e complici dell' uccissione, inconscia la famiglia Cènci, e la innocentissima Beatrice. Per mezzo della polizia spagnola napoletana, perocchè in Napoli fosse la mala signorio spagnola, venne a scoprire le tracce di Olimpio e di Marzio, i quali sguazzavano nell'oro, prezzo del loro silenzio. Il primo di questi, Olimpio, fu ucciso da un sicario mandato da Guido Guerra, l'altro, Marzio, fu preso e condotto nelle carceri di Roma, dove morì fra i tormenti della tortura, proclamando sè colpevole, innocente Beatrice. Questa imprudente aveva regalato ad una povera donna di Rocca Petrella due lenzuoli intrisi di sangue. Questa circostanza fu il fondamento dell' accusa contro l' infelice fanciulla. Il resto della famiglia Cènci, non reggendo agli orrori della tortura, confessò un non commesso delitto, ma essa, imperterrita, dignitosamente respingeva l'accusa, dichiarandosi innocente. Anche la matrigna, Lucrezia, Giacomo ed il fanciullo Bernardo Cènci, incoraggiati dall'esempio di Beatrice, dichiararono nulla la confessione, estorta coi tormenti della tortura, e sè medesimi innocenti. Ma papa Clemente VIII voleva la morte dei Cènci, e colla morte la confisca della sostanza loro patrimonio; ma essi non avevano confessato, e quindi non potevasi, a forma delle leggi, confiscarne i beni. Ma ad un papa carnefice e ladro non mancano mezzi per ottenere un fine. Fece promettere dal Farinaccio, celebre magistrato e in questo affare anch'esso ingannato, ai Cènci che se avessero confessato il delito, avreb bero avuta la grazia, e ne impegnava la sua papale parola. I Cènci caddero nell' aggato, si dissero rei, ed allora furono condannati a morte. Il Farinaccio, vedendosi ingannato, ricorse al Papa, il quale, battendo il piede sul pulvinare di velluto, con voce tonante rispose: Bisogna che muoino. Giacomo, Bernardo, Lucrezia Petroni e Beatrice furono condannati a morte col taglio della testa; il primo (Giacomo) doveva essere attanagliato e poi squartato. Le campane col lugubre squillo invocano la preghiera per gli agonizzanti; i tamburi snonano scordati; il cielo e la terra pareva che con quei suoni si scambiassero l' annunzio che la strage era per compiersi, e ne rimanessero sbigottiti. Nel cortile stavano attelati parecchi sbirri a piedi, e poi i fratelli della

in cui si trovava e una prigione; l'aspetto della stanza apparisce
strano a vedersi: splendido e il letto per cortine ampissime di
damasco e cornici dorate, ricuopre il pavimento uno splendido
arazzo; le finestre erano chiuse da una ferrata, davanti alla quale era
inchiodato un assito a modo di tramoggia, e sopra questa adattata una
graticola fitta di filo di ferro; quivi gemeva la povera Beatrice; ma
anco da questo luogo le era riuscito avvisare l'amato Guido Guerra,
supplicandolo di pronto aiuto. — E notte. Uu lieve tocco sospinge la
porta; ecco si muove silenziosa sui cardini: prima il capo, poi il petto
—finalmente tutta la persona apparisce di un uomo canuto, avvolto in
un'ampia zimarra. — È il conte Cenci strascinato dal destino. Tende
l'orecchio... ascolta l' alito di Beatrice. Appoggia il corpo intero sul
piede di dietro, muove cauto l'altro, e sempre va innanzi; si ferma in
fondo al letto. Beatrice ha chiuso gli occhi a sonno travagliato, e

agitandosi irrequieta si e scomposta la chioma, che le sta vag-
amente sparsa pel seno divino.—Egli la guarda.  La vista di
forme cosi stupendamente leggiadre rallegra l'annima.—Che
ardisce costui?  Non basta, ed e anche troppo, vedere quel seno
che palpita?––Il truce vecchio stende le scarne braccia, e trae
a se cautissimo i lini.  I tesori di coteste membra appaiono
manifesti.—Cheta, cheta la porta della stanza torna di nuopo
a polgersi sopra gli arpioni: entra un altr'uomo e si ferma:—
guarda..... stupisce.... e non ravvisa il Conte al fioco chiarore del
lume, che peglia fra loro.   Il Conte, lussuriando per ogni fibra,

trema; gli occhi gli si aggrin-
ziscono a modo di vipera: una
striscia di fiamma d' etico gli
imporpora  il  sommo  delle
gote; lascia cadersi giu dalle

spalle la zimarra,
e appaiono le pal-
lide membra del

דיא נאנצע שטערנזעל שוועגטאן האט געקלונגען ווא מיט א גלאק וועגען דעם וויכטיגען נייעס
וואס דארט האט געבראפען.    און דער פאל איז ווירקליך פארגעקומען ווילר ביי אלע אייכואהנער
פון דער קליינער שטעדטיל.    יעדערער האט מיט פערוואנדערונג ערצעהלט דעם זעלבעגעם
נייעם: דאס יאהנא זרונע דיא ווישער'ן האט ערהאלבען א בריעף פון איהר מאן זלמנקע פיא=
ניצע, אוים אמעריקא, אז איהם איז דארט זעהר גוט און אז ער שיקט איהר אין גיבען ארוים
גאנצע צעהן קארבען.    זלמנקע פיאניצע איז געווען א מענבש כון דער ניערערינגעסטער קלאסכע
אין שוועגטאן, ער האט ראהרט גאר ניט פארריעגט, האטש ער איז געווען א געזונדער יוד מיט
ביינער.    ער האט גור געלעבט דער כון וואס זיין וויב יאהנע גרונע האט וועט געוואיבען, נאר
איין וואך אין יאהר האט ער פערדיענט פינף גילדען, ראם איז געווען דער פון וואס ער האט גע=
רארפט אין הרש אלול וועקען דיא בעלי בתים צו כלירות און דיא פינף גילדען האט ער אין לעבעבען
יאהר אויך פערלארען און האט געקריגען אבגעזאגט פון זיין שטע'לע דורך אן אונגליקליכען צופאל

דורך וועלכען ער האט אבנעקריינקט דרייא וואכען    עם איז געווען אין א פינסטערען פארכאן,
אין זיך זלמנקע ארוים‌גענאנגען מיט זיין נרויכען זכעקען וועקען דיא בעלי בתים.    גאר נעהענדיג
אין דער פינסטער איז ער פערקראאכען צום פריכטאוס הויז, און ניט בעמערקענדין אז ער איז
לעבען פריסטאוו,    איז ער צונעגאננען צו דיא לאדען און האט שטארק אננעהייבען צו קלאפען
מיט זיין שטעקען מיט גוואלדען: שטייט אויף צו כל'חות.    דער פריכטאוו איז ניט טויט ניט
לעבעדיג אויפגעש'פרונגען פון זיין געלעגנער און האט וואס ניכער ארוים‌געשיקט א נאר'ראואוו
זעהן וואס איז דאם פאר א סקאנדאל אין דרויסען . . . נוא, נוא, וואם ווילט איהר ? דער אריימער
זלמנקע האט געקריעגען ש'יינע עטליכע קלעפ  און אויך אכט כאג ארעכט.    פון דעם מאהל אן
האט מען איהם אבגעזאנגט און ער האט פערלאארען זיין שטעלע.    דעם זיסטען נאמען פיאניצע
האט ער נעקריגען האטש‌ט ער וואר קיין פיאניצע.    ער האט אין מאהל וען ער איז נעווען אויף
א חתונה האט ער ניט ווילענדיג צוברואכען א גרויסע פלאש שנאפס, אלם מיא האט אננעהייבען
זוכען דיא שנאפס און עם איז ניט נעווען, איז ביי אלעמען קיין צוווייפעל נעווען, דאס יעמאנד האט
דיא שנאפס נעשטוילען, נאר פלוצלינג האט א קליינער יונגע אויסנעשריען: ,,אוי הערט זיך דאס

פון זלמנקען שנאפם! אז מיא קען לעבען איהם ניט איינ־
שטיין''. אלע זיינען צוגעלאפען צו זלמנען, און ווירקליך
עם האט זיך פון איהם געטראגען איין שנאפסיגער
אראמאט אזוי ווי פון א גוטען שכור, ביא אלעמען איז
שוין איצט רעכט געוואורען ווו דיא פלאש שנאפס איז
פערפאלען געוואורען, און מיא האט זלמנהען געקריינט
מיט דעם נאמען ,,פיאניצע'', וועלכער איז ביא איהם
פערבליעבען ביז אויף היינטיגען טאג.    זלמנקען איז

געוואָרען אין דער לעצטער צייט

זעהר שלעכט, זיינע פיער קינדער-

לעך זיינען אונטער געוואקסען, זיין

עלטערע מיידעל איז שוין אלט

געוואָרען 17 יאהר, זיא

האָט אפילו געהאָלפען

דער מוטער וועש וואָ-

שען אבער נאך אלע

זאבען האבען זייא

The letters are based on an angle of 4 minutes, as the
standard acuity of vision.

80 R P F 20

40 Z E N H 10

20 B A R X K T F 6

16 F Y T P E Z C G 5

13 D C O C A R X K 4

10 Z N H E B S Y T 3

(33)
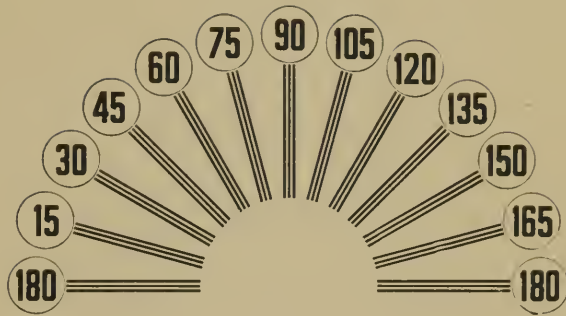
## DR. JAMES WALLACE'S

### ASTIGMATIC CHART.

Adapted to normal visual acuity at one metre, (or 40 inches), and shorter distances as the visual acuity is lowered.

# FERGUSON & WESTON'S TEST
## FOR MUSCLE BALANCE.

### FIGURE I.

This prism scale is to be held at
30 centimetres from the eyes. Each
division represents the deviation of a
prism of one degree to the right or left.

A ten-degree prism is to be placed
over the right eye with its base down-
wards. The upper star is to be fixed
and the row of figures just above it is
focussed sharply.

The point of the star will mark how
many degrees of deviation are present.
If the upper star is to the right it is
esophoria. If the upper star is to the
left it is exophoria.

### FIGURE 2.

This scale is to be held at 30 centi-
metres from the eyes, each division
will then represent the deviation of a
prism of one degree.

A twenty-degree prism is to be
placed in front of the right eye with
its base towards the nose, and the
right star observed. If the right star
is above, there is left hyperphoria.
If the right star is below, there is
right hyperphoria.

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## JACKSON'S TEST FOR MUSCLE BALANCE
## AT WORKING DISTANCE.

———•———

The white square on a black ground is held at the working distance and looked at through a strong cylinder (20 to 40 D), held before one eye through which the white spot appears as a grey streak. To test the vertical balance the axis of the cylinder is held vertical. The streak then appears horizontal. To test the lateral balance the axis is held horizontal, the streak appears vertical. In orthophoria the streak appears to pass through the spot. Displacement of the streak the width of the spot represents heterophoria of one quarter degree when the test is held at one-third of a metre. Greater degrees of heterophoria are measured by the prism required to bring the streak upon the square, The cylinder should be held an inch or two in front of the eye, and its centre must be in the line of sight when the eyes are fixed on the white square, or the streak will not come opposite the square.

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# The Cobalt Glass Test for Heterophoria,

—BY—

## DR. HOWARD F. HANSELL.

The value of this, (as of most tests for anomalies of the ocular muscles) depends upon its disturbing influence on the power of fusion and the induction of a diplopia that, without extraordinary efforts of co-ordination, is insuperable. It consists of a piece of thick glass stained with cobalt-blue, ground with parallel surfaces and cut to fit the cell of the trial frame. All the rays of light entering such a piece of glass are absorbed, with the exception of the blue and the red which emerge unrefracted to an appreciable degree, from their original direction. The retinal image of a light, the rays of which have been modified by the cobalt glass, is therefore smaller because of the absorption of the majority of the constituents of white light, and not through focusing of those rays to a point, and is colored red and blue. The difference between this image and that seen by the eye before which no glass is placed is so marked that the brain unconsciously and involuntarily recognizes it as the image of another distinct and separate light and thus ceases its effort to preserve singular binocular fixation. Should both images fall on the foveæ, we have single images and equilibrium or a low grade of muscular inco-ordination. Should the images not fall on corresponding points of each retina, we have, as indicated by the relative positions of the lights, heterophoria or heterotropia. The eye before which the cobalt glass is held is permitted by the psychic effect of change in size, color, and shape of the light, to wander into a position that is most restful for it as indicated by the change in location of the light as seen through the cobalt glass. The findings will invariably agree and are a true indication of relative directions of the visual axes, when relieved of the desire to maintain single vision, whether the glass is held before the right or the left eye. This test is inferior to some of the others because latent defects of lateral inco-ordination of two or three degrees only, or half or one degree of vertical tendencies are not manifested. Its superiority to the prism displacement test consists in the determination of heterophoria under like conditions of double foveal perception and not by a comparison of deviations induced by a foveal image in one, and an extra-foveal image in the other eye, since it serves to dissolve fusion without alteration of the direction of the rays of light proceeding from the test object.

We are prepared to furnish the proper cobalt blue glass for Dr. Hansell's test, either in cells to fit trial frames or in square pieces to hold in the hands.

FERGUSON & WESTON,

Opticians,

N. E. Cor. 15th and Chestnut Streets, Philadelphia.

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# Dr. S. Lewis Ziegler's Greek Cross Test Object for Muscle Balance.

The Greek Cross test object was devised as a substitute for the candle or small gas flame in the Graefe test. It consists of a plain Greek cross, cut out of blackened metal, and placed over a thin strip of porcelain, behind which is stationed a gas or electric light, which is concealed by a blackened metal hood. It is used by placing the red glass over the right eye, and either P 8° base in, or P° 5 base up, as a displacing prism over the left eye. It was first devised for use during the operation of partial tenotomy. The satisfaction in its use for operative cases has led to its adoption for all heterophoric work. It has proved itself more reliable than either the Graefe or Maddox tests.



A smaller Greek cross, printed in black, on cardboard, is used as a near test object in preference to either the Graefe line and ball, the ball alone, or the single word test object. The following advantages have been found to accrue from the use of this test object :

1. The Greek cross test object is easily recognized by the patient, even under the partial blurring of vision during tenotomy.

2. The patient can accurately line up the vertical deviation by the horizontal arms of the cross, and the horizontal deviation by the vertical arms of the cross.

3. The four arms of the cross attract the attention of the eye separately, causing complete dissociation of the two images, with muscular relaxation. Hence the tendency to fuse is almost nil.

4. A *series* of examinations shows less variation than by other methods, which goes to prove the constancy, accuracy, and reliability of this test, and the thorough elimination of all disturbing factors.

5. The test for near, by the small black cross, is likewise more accurate than by other methods, and the error more manifest, for the same reasons that apply to the distance test.

# The Practical Methods for Determining the Ocular Balance.

## By DR. S. D. RISLEY.

The ideal conditions for comfortable binocular vision are, a pair of emmetropic eyes with normal acuity of vision in each, and the physiological range of accommodation and convergence. These ideal conditions are disturbed, and abnormalities of ocular balance introduced : (1) by the presence of an error of refraction ; (2) by interference with muscular innervation ; (3) by some anatomical abnormality in the muscles, *e. g.* in their length and direction, their origin, or their attachment to the globe. The first and most simple method for determining the presence of abnormal balance is the cover test, which usually gives important and valuable suggestions as to the character and extent of any existing defect. The method of application is important. A glare of strong light in the face of the patient should be avoided. The eyes being maintained in the primary position should be fixed upon some definite object at a distance of at least $6^m$. A black card or cover should then be held in each hand by the surgeon so that either eye can be rapidly covered or exposed. Hold the cover over one steadily for a few seconds, allowing the other to fix the observed object. When the cover is removed, if the eyes are properly balanced, no movement will take place, the covered eye has remained in the same relative position as its fellow. The eye moves inward to fix the observed object, exophoria is suggested ; it moves outward to fix, esophoria is suggested ; it moves upward or downward to fix, hyperphoria is suggested. The covers may then be placed alternately before each eye in slow or rapid succession when the movements made in order to fix with each eye afford suggestions as above noted. In either method the degree of movement made affords also some intimation as to the degree of abnormality. The estimated degree may then be verified by placing prisms in the trial frames and repeating the test by cover until no movement of the eyes is observed in the act of fixing. The same test may then be repeated at a finite point, usually at the reading distance. The point of a pin furnishes a good test object, since to be seen accurately it calls into action the power of accommodation. More accurate measurements should then be made with some fixed form of apparatus, which will insure a perfect leveling of the glasses, prisms, etc., to be employed.

Probably the best test object is a small bright point of light before a dead black background. A candle flame is too large for great accuracy. The first step is to secure some means of differentiating the image seen by each eye. This may be done in a variety of ways ; (1) by means of a dark red glass which will often develop diplopia in the presence of even minor grades of imbalance ; (2) by the Maddox Rod, or Double Prism, or a strong cylinder placed before one eye. The rod and cylinder convert a point of light into a streak, the double prism properly placed causes two images in the same eye

usually connected by a line of light. The relative position of the streak of light or double images, to the light seen by the other eye enables the observer to determine the relative position assumed by the eyes of the patient. (3) By the diplopia test. A prism of sufficient strength to cause diplopia is placed vertically before one eye to test the lateral ocular balance and horizontally, preferably with its base toward the nose for testing the vertical balance ; (4) a Maddox Rod of white glass may be placed before one eye, and of red glass before the other. If the ocular balance is perfect, the white and red streaks of light should blend both in the vertical and horizontal position. The principal involved is the same in each of these methods. If the streak, double image, or displaced image, _e. g._ is seen with the right eye, and the undisturbed image of the light or other test object is seen with the left eye, then, in exophoria the images will be crossed, in esophoria they will be homonomous ; in right hyperphoria the displaced image will be too low ; in left hyperphoria, too high. The most convenient, rapid and correct method of measuring the extent of the deviation manifested by either of these methods is by means of rotary prisms, mounted in some fixed, stable apparatus, since considerable errors may be introduced by the deviation of the trial frames from a horizontal position. The findings by any of these methods are often erroneous, and the apparent errors discovered may be measurements of spastic conditions of the extraocular muscles associated with tonic cramp of the accommodation.

No study is complete that does not include the power of abduction, adduction, and sursumduction. The power of the muscles can be measured best by a pair of rotary prisms, one before each eye, firmly fixed and level. The patient should be in a restful posture, but erect, and the eyes in the primary position. The most satisfactory test object is a small point of light placed at $6^m$ before a dead black background, and free from surrounding objects. The prisms being placed with the zero point vertical, should be rotated slowly but steadily in the direction to secure first the abducting power. As soon as diplopia is produced, the prisms should be turned back into a neutral position, and the patient given repeated opportunity to verify the first result. The adduction and sursumduction should then be determined in exactly the same manner, the zero-point of the prism being horizontal—in measuring the power of the vertically acting muscles. In emmetropic, or in corrected and normally balanced eyes, the abduction and adduction should be approximately as 1. is to 3. 1° of abduction to 3° of adduction. Any considerable departure from this working basis will ordinarily reveal itself in deviation by one or all of the above described methods. The average dynamic force of the vertically acting muscles in correctly balanced eyes as measured in the manner described is 2½° to 3½° or 4°.

All errors of refraction should be carefully and totally corrected, and the ocular balance determined through the accurately centered correcting glasses.

# DR. JAMES WALLACE'S

## Table Giving the Degree of the Prism and the Angle of Rotation to Produce the Effect of two Prisms with their Bases at Right Angles.

| Prisms required | Deg. of Prism | Ang. of rotation | Prisms required | Deg. of Prism | Ang. of rotation | Prisms required | Deg. of Prism | Ang. of rotation | Prisms required | Deg. of Prism | Ang. of rotation | Prisms required | Deg. of Prism | Ang. of rotation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ° | ° ′ | | ° | ° ′ | | ° | ° ′ | | ° | ° ′ | | ° | ° ′ |
| 1X1 | 1.4 | 45 | 1X2 | 2.2 | 26.34 | 1X3 | 3.2 | 18.26 | 1X4 | 4.1 | 14.02 | 1X5 | 5.1 | 11.19 |
| 2X1 | 2.2 | 63.26 | 2X2 | 2.8 | 45 | 2X3 | 3.6 | 33.42 | 2X4 | 4.5 | 26.34 | 2X5 | 5.4 | 21.48 |
| 3X1 | 3.2 | 71.34 | 3X2 | 3.6 | 56.18 | 3X3 | 4.2 | 45 | 3X4 | 5 | 36.02 | 3X5 | 5.8 | 30.58 |
| 4X1 | 4.1 | 75.58 | 4X2 | 4.5 | 63.26 | 4X3 | 5 | 53.08 | 4X4 | 5.7 | 45 | 4X5 | 6.4 | 38.40 |
| 5X1 | 5.1 | 78.41 | 5X2 | 5.4 | 68.12 | 5X3 | 5.8 | 59.02 | 5X4 | 6.4 | 51.20 | 5X5 | 7 | 45 |
| 6X1 | 6.1 | 80.32 | 6X2 | 6.3 | 71.33 | 6X3 | 6.7 | 63.26 | 6X4 | 7.2 | 56.18 | 6X5 | 7.8 | 50.11 |
| 7X1 | 7.1 | 81.52 | 7X2 | 7.3 | 74.3 | 7X3 | 7.6 | 66.47 | 7X4 | 8 | 60.14 | 7X5 | 8.6 | 54.27 |
| 8X1 | 8 | 82.51 | 8X2 | 8.2 | 75.57 | 8X3 | 8.5 | 69.26 | 8X4 | 8.9 | 63.25 | 8X5 | 9.4 | 57.59 |
| 9X1 | 9 | 83.39 | 9X2 | 9.2 | 77.27 | 9X3 | 9.5 | 71.33 | 9X4 | 9.8 | 66.01 | 9X5 | 10.3 | 60.56 |
| 10X1 | 10 | 84.17 | 10X2 | 10.2 | 78.18 | 10X3 | 10.4 | 73.09 | 10X4 | 10.8 | 68.10 | 10X5 | 11.2 | 63.25 |

| Prisms required | Deg. of Prism | Ang. of rotation | Prisms required | Deg. of Prism | Ang. of rotation | Prisms required | Deg. of Prism | Ang. of rotation | Prisms required | Deg. of Prism | Ang. of rotation | Prisms required | Deg. of Prism | Ang. of rotation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1X6 | 6.1 | 9.28 | 1X7 | 7.1 | 8.8 | 1X8 | 8 | 7.09 | 1X9 | 9 | 6.21 | 1X10 | 10 | 5.43 |
| 2X6 | 6.3 | 18.27 | 2X7 | 7.3 | 15.57 | 2X8 | 8.2 | 14.03 | 2X9 | 9.2 | 12.33 | 2X10 | 10.2 | 11.42 |
| 3X6 | 6.7 | 26.34 | 3X7 | 7.6 | 23.13 | 3X8 | 8.5 | 20.34 | 3X9 | 9.5 | 18.27 | 3X10 | 10.4 | 16.51 |
| 4X6 | 7.2 | 33.42 | 4X7 | 8 | 29.46 | 4X8 | 8.9 | 26.35 | 4X9 | 9.8 | 23.59 | 4X10 | 10.8 | 21.50 |
| 5X6 | 7.8 | 39.49 | 5X7 | 8.6 | 35.33 | 5X8 | 9.4 | 32.1 | 5X9 | 10.3 | 29.04 | 5X10 | 11.2 | 26.35 |
| 6X6 | 8.4 | 45 | 6X7 | 9.2 | 40.37 | 6X8 | 10 | 36.53 | 6X9 | 10.8 | 33.42 | 6X10 | 11.7 | 30.59 |
| 7X6 | 9.2 | 49.23 | 7X7 | 9.9 | 45 | 7X8 | 10.6 | 41.11 | 7X9 | 11.4 | 37.44 | 7X10 | 12.3 | 35.01 |
| 8X6 | 10 | 53.7 | 8X7 | 10.6 | 48.49 | 8X8 | 11.3 | 45 | 8X9 | 12.1 | 41.39 | 8X10 | 12.8 | 38.40 |
| 9X6 | 10.8 | 56.18 | 9X7 | 11.4 | 52.6 | 9X8 | 12.1 | 40.21 | 9X9 | 12.8 | 45 | 9X10 | 13.5 | 42 |
| 10X6 | 11.7 | 59.1 | 10X7 | 12.3 | 54.59 | 10X8 | 12.8 | 51.20 | 10X9 | 13.5 | 48 | 10X10 | 14.1 | 45 |

If the base of a prism is rotated 36° 53′ from the vertical meridian, it is 53° 7′ from the horizontal meridian. The prismatic effect in the vertical meridian, 36° 53′ from the base of the prism, is $\frac{8}{10}$ of the prism. The prismatic effect in the horizontal meridian, 53° 7′ from the base of the prism, is $\frac{6}{10}$ the value of the prism. The base of the prism is rotated a smaller arc for the larger effect and vice versa. The direction of the base is the direction of the perpendicular to the base.

## Jackson: Decentering of Lenses for Prismatic Effects, with Glass having an Index of Refraction of about 1.54.

| Power of Lens in Dioptres. | To obtain 1° Prism Decentre mm. | To obtain 2° Prism Decentre mm. | To obtain 3° Prism Decentre mm. | To obtain 4° Prism Decentre mm. | To obtain 5° Prism Decentre mm. | To obtain 6° Prism Decentre mm. | To obtain 8° Prism Decentre mm. | To obtain 10° Prism Decentre mm. |
|---|---|---|---|---|---|---|---|---|
| 1 D., | 9.4 | 18.8 | 28.3 | 37.7 | 47.2 | 56.5 | 75.8 | 95.2 |
| 2 | 4.7 | 9.4 | 14.1 | 18.8 | 23.6 | 28.2 | 37.9 | 47.6 |
| 3 | 3.1 | 6.3 | 9.4 | 12.6 | 15.7 | 18.8 | 25.3 | 31.7 |
| 4 | 2.3 | 4.7 | 7.1 | 9.4 | 11.8 | 14.1 | 18.9 | 23.8 |
| 5 | 1.9 | 3.8 | 5.7 | 7.5 | 9.4 | 11.3 | 15.2 | 19. |
| 6 | 1.6 | 3.1 | 4.7 | 6.3 | 7.9 | 9.4 | 12.6 | 15.9 |
| 7 | 1.3 | 2.7 | 4. | 5.4 | 6.7 | 8.1 | 10.8 | 13.5 |
| 8 | 1.2 | 2.3 | 3.5 | 4.7 | 5.9 | 7.1 | 9.5 | 11.9 |
| 9 | 1. | 2.1 | 3.1 | 4.2 | 5.2 | 6.3 | 8.4 | 10.5 |
| 10 | .9 | 1.9 | 2.8 | 3.8 | 4.7 | 5.6 | 7.6 | 9.5 |
| 11 | .9 | 1.7 | 2.6 | 3.5 | 4.3 | 5.1 | 6.9 | 8.7 |
| 12 | .8 | 1.6 | 2.4 | 3.1 | 3.9 | 4.7 | 6.3 | 7.9 |
| 13 | .7 | 1.4 | 2.2 | 2.9 | 3.6 | 4.3 | 5.8 | 7.3 |
| 14 | .7 | 1.3 | 2. | 2.7 | 3.4 | 4. | 5.4 | 6.8 |
| 15 | .6 | 1.3 | 1.9 | 2.5 | 3.1 | 3.8 | 5.1 | 6.3 |
| 16 | .6 | 1.2 | 1.8 | 2.4 | 3. | 3.5 | 4.7 | 6. |
| 17 | .6 | 1.1 | 1.7 | 2.2 | 2.1 | 3.4 | 4.5 | 5.6 |
| 18 | .5 | 1. | 1.6 | 2.1 | 2.6 | 3.1 | 4.2 | 5.3 |
| 19 | .5 | 1. | 1.5 | 2. | 2.5 | 3. | 4. | 5. |
| 20 | .5 | .9 | 1.4 | 1.9 | 2.4 | 2.8 | 3.8 | 4.8 |

Transactions of the American Ophthalmological Society.

# EQUIVALENT NUMBERS OF PRISMS —JACKSON.

The first column gives the number of each prism according to the new system, indicating its power of caus-
ing deviation in the rays of light passing through it expressed in *centrads*. The second column gives the same
deviating power expressed in *prism dioptres*. The third column gives the refracting angle of the prism, (its num-
ber by the old system), which will cause this same deviation, when the prism has one surface perpendicular to the
rays, and the glass has an index of refraction of 1.54.

| Deviation in Centrads. | Deviation in Prism Dioptres | Refracting Angle in Degrees. | Deviation in Centrads. | Deviation in Prism Dioptres | Refracting Angle in Degrees. | Deviation in Centrads. | Deviation in Prism Dioptres . | Refracting Angle in Degrees. |
|---|---|---|---|---|---|---|---|---|
| 1 | 1· | 1·06 | 9 | 9·02 | 9·39 | 17 | 17·16 | 16·98 |
| 2 | 2· | 2·12 | 10 | 10·03 | 10·39 | 18 | 18·19 | 17·85 |
| 3 | 3· | 3·18 | 11 | 11·03 | 11·37 | 19 | 19·23 | 18·68 |
| 4 | 4· | 4·23 | 12 | 12·04 | 12·34 | 20 | 20·26 | 19·45 |
| 5 | 5· | 5·28 | 13 | 13·06 | 13·29 | 25 | 25·53 | 23·42 |
| 6 | 6·01 | 6·32 | 14 | 14·08 | 14·23 | 30 | 30·93 | 26·81 |
| 7 | 7·01 | 7·35 | 15 | 15·11 | 15·16 | 40 | 42·38 | 32·18 |
| 8 | 8·02 | 8·38 | 16 | 16·14 | 16·08 | 50 | 54·62 | 36·03 |

**Dr. Edward Jackson, Ophthalmic Review.**

**PRISM SCALE**

BY DR. S. LEWIS ZIEGLER,

ADJUSTED FOR MEASURING THE STRENGTH OF PRISMS
AT A DISTANCE OF TWO METERS

PRISM UNIT = { 1 CENTIMETER DEVIATION AT A DISTANCE OF 1 METER }
{ 2 CENTIMETERS DEVIATION AT A DISTANCE OF 2 METERS }
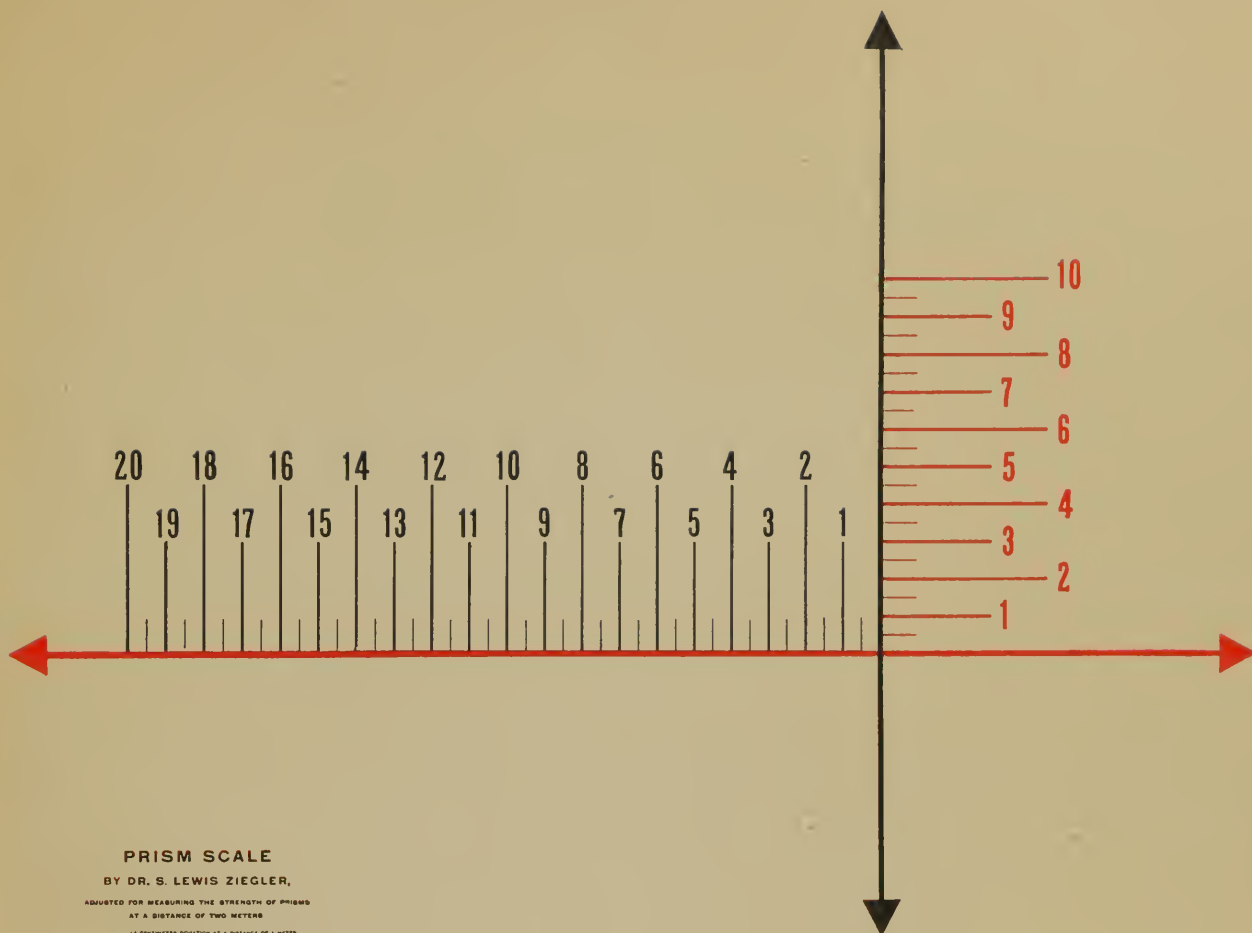
## DIRECTIONS FOR USING DR. ZIEGLER'S PRISM SCALE.

The prism scale herewith shown can be used at a distance of a half meter, but a larger one for use at two meters is preferable, as the possibility of error is much less.

To use the scale close one eye, and with the other look at the scale both *through* the prism and *over* it. A comparison of these two views gives the required registration. Each field must contain either the *indicator* singly or the numbered *gradations* singly ; the fields being in conjunction at the margin of the lens.

Rotate the prism until the base line seen through the prism is continuous with the base line of the scale. Always keep the plane of the prism parallel with that of the scale, and on a level with it. The index line will be displaced along the scale until the indicator stands opposite the proper numbered gradation. By moving the prism up and down, along this gradation, it can be seen whether the index line accurately coincides or not.

To ascertain the strength of a pair of prismatic spectacles, place the neutralizing sphero-cylinder over the spectacle lens, and proceed to take the reading of the scale. If the lenses are evenly held, it can be seen (1) whether the lens is properly neutralized, (2) whether it is accurately centered, and (3) whether the prismatic strength is correctly measured.

# Dr. Wallace's Table for Reducing Crossed Cylinder Lenses to a Sphero-Cylindrical Combination.

RULE 1.—All crossed cylinder combinations with the same ratio, viz: + 1 to + 2 and + 3 to + 6, or + 1 to + 3 and + 2 to + 6, will have the axis of the resultant cylinder at the same angle, and the spherical and cylindrical lenses of one combination will be multiples or fractions of the spherical and cylindrical lenses of the other.

RULE 2.—The two cylinders may lie in any part of the arc of 180° it is easy to find the angle of the resultant cylinder by keeping it at the same angle from the weaker or stronger cylinder, as the cylinders are moved to new positions.

RULE 3.—By observing the difference in the spherical and cylinder in passing through 10 or 15 degrees, changes of 5° in the distance between the axes may be made by dividing the difference between sphericals in 10° into two parts or in 15° into three parts and subtracting from the higher spherical. In the same way the difference between the cylinders is to be divided into two or three parts and subtracted from the higher or added to the lower. Example:

$$+ 1 \text{ cyl. ax. } 90 + 3 \text{ cyl. ax. } 15 = + .87 + 2.25 \text{ cyl. ax. } 22$$
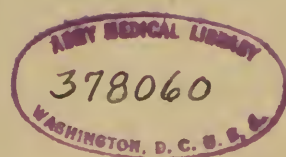$$+ 1 \text{ cyl. ax. } 90 + 3 \text{ cyl. ax. } 25 = + .75 + 2.50 \text{ cyl. ax. } 32$$
$$\frac{12}{12} \qquad \frac{25}{25}$$
$$+ 1 \text{ cyl. ax. } 90 + 3 \text{ cyl. ax. } 20 = + .81 + 2.37 \text{ cyl. ax. } 27$$
$$\frac{10}{10}$$

| Cylinder | Cylinder | Spherical | Cylinder |
|---|---|---|---|
| + 1 cyl. ax. 90 | + 1 cyl. ax. 15 | + .75 | + .87 cyl. ax. 52½ |
| + 1 cyl. ax. 90 | + 1 cyl. ax. 30 | + .50 | + 1. cyl. ax. 60 |
| + 1 cyl. ax. 90 | + 1 cyl. ax. 45 | + .25 | + 1.37 cyl. ax. 67½ |
| + 1 cyl. ax. 90 | + 1 cyl. ax. 60 | + .12 | + 1.75 cyl. ax. 75 |
| + 1 cyl. ax. 90 | + 1 cyl. ax. 75 | | + 1.87 cyl. ax. 82½ |
| + 1.25 cyl. ax. 90 | + 1.25 cyl. ax. 15 | + .87 | + .62 cyl. ax. 51 |
| + 1.25 cyl. ax. 90 | + 1.25 cyl. ax. 30 | + .50 | + 1.12 cyl. ax. 55 |
| + 1.25 cyl. ax. 90 | + 1.25 cyl. ax. 45 | + .37 | + 1.62 cyl. ax. 64 |
| + 1.25 cyl. ax. 90 | + 1.25 cyl. ax. 60 | + .12 | + 2. cyl. ax. 74 |
| + 1.25 cyl. ax. 90 | + 1.25 cyl. ax. 75 | | + 2.25 cyl. ax. 82 |
| + 1.50 cyl. ax. 90 | + 1.50 cyl. ax. 15 | + .87 | + .75 cyl. ax. 51 |
| + 1.50 cyl. ax. 90 | + 1.50 cyl. ax. 30 | + .62 | + 1.37 cyl. ax. 31 |
| + 1.50 cyl. ax. 90 | + 1.50 cyl. ax. 45 | + .37 | + 1.75 cyl. ax. 62 |
| + 1.50 cyl. ax. 90 | + 1.50 cyl. ax. 60 | + .12 | + 2.25 cyl. ax. 72 |
| + 1.50 cyl. ax. 90 | + 1.50 cyl. ax. 75 | | + 2.50 cyl. ax. 81 |
| + 1.75 cyl. ax. 90 | + 1.75 cyl. ax. 15 | + .87 | + 1. cyl. ax. 31 |
| + 1.75 cyl. ax. 90 | + 1.75 cyl. ax. 30 | + .62 | + 1.50 cyl. ax. 49 |
| + 1.75 cyl. ax. 90 | + 1.75 cyl. ax. 45 | + .37 | + 2. cyl. ax. 60 |
| + 1.75 cyl. ax. 90 | + 1.75 cyl. ax. 60 | + .12 | + 2.37 cyl. ax. 70 |
| + 1.75 cyl. ax. 90 | + 1.75 cyl. ax. 75 | | + 2.75 cyl. ax. 80 |
| + 2 cyl. ax. 90 | + 2 cyl. ax. 15 | + .87 | + 1.25 cyl. ax. 27 |
| + 2 cyl. ax. 90 | + 2 cyl. ax. 30 | + .62 | + 1.75 cyl. ax. 45 |
| + 2 cyl. ax. 90 | + 2 cyl. ax. 45 | + .37 | + 2.25 cyl. ax. 58 |
| + 2 cyl. ax. 90 | + 2 cyl. ax. 60 | + .12 | + 2.62 cyl. ax. 69 |
| + 2 cyl. ax. 90 | + 2 cyl. ax. 75 | | + 3. cyl. ax. 80 |
| + 2.25 cyl. ax. 90 | + 2.25 cyl. ax. 15 | + .87 | + 1.50 cyl. ax. 25 |
| + 2.25 cyl. ax. 90 | + 2.25 cyl. ax. 30 | + .62 | + 1.75 cyl. ax. 43 |
| + 2.25 cyl. ax. 90 | + 2.25 cyl. ax. 45 | + .37 | + 2.50 cyl. ax. 57 |

| Cylinder | Cylinder | Spherical | Cylinder |
|---|---|---|---|
| + 1 cyl. ax. 90 | + 2.25 cyl. ax. 60 | + .25 | + 2.75 cyl. ax. 69 |
| + 1 cyl. ax. 90 | + 2.25 cyl. ax. 75 | | + 3.25 cyl. ax. 80 |
| + 2.50 cyl. ax. 90 | + 1 cyl. ax. 15 | + .87 | + 1.75 cyl. ax. 82 |
| + 2.50 cyl. ax. 90 | + 1 cyl. ax. 30 | | + 2.25 cyl. ax. 78 |
| + 2.50 cyl. ax. 90 | + 1 cyl. ax. 45 | + .62 | + 2.75 cyl. ax. 79 |
| + 2.50 cyl. ax. 90 | + 1 cyl. ax. 60 | + .37 | + 3.25 cyl. ax. 81 |
| + 2.50 cyl. ax. 90 | + 1 cyl. ax. 75 | + .25 | + 3.50 cyl. ax. 86 |
| + 1 cyl. ax. 90 | + 2.75 cyl. ax. 30 | | + 2. cyl. ax. 22 |
| + 1 cyl. ax. 90 | + 2.75 cyl. ax. 45 | + .87 | + 2.50 cyl. ax. 41 |
| + 1 cyl. ax. 90 | + 2.75 cyl. ax. 60 | + .62 | + 3. cyl. ax. 55 |
| + 1 cyl. ax. 90 | + 2.75 cyl. ax. 15 | + .37 | + 3.50 cyl. ax. 67 |
| + 3 cyl. ax. 90 | + 1 cyl. ax. 25 | | + 3.75 cyl. ax. 79 |
| + 3 cyl. ax. 90 | + 1 cyl. ax. 35 | + .87 | + 2.25 cyl. ax. 22 |
| + 3 cyl. ax. 90 | + 1 cyl. ax. 45 | + .75 | + 2.50 cyl. ax. 32 |
| + 3 cyl. ax. 90 | + 1 cyl. ax. 55 | + .62 | + 2.87 cyl. ax. 45 |
| + 3 cyl. ax. 90 | + 1 cyl. ax. 65 | + .37 | + 3.12 cyl. ax. 54 |
| + 3 cyl. ax. 90 | + 1 cyl. ax. 75 | + .12 | + 3.50 cyl. ax. 63 |
| + 3 cyl. ax. 90 | + 3 cyl. ax. 15 | | + 3.75 cyl. ax. 71 |
| + 3.50 cyl. ax. 90 | + 1 cyl. ax. 30 | + .87 | + 4. cyl. ax. 79 |
| + 3.50 cyl. ax. 90 | + 1 cyl. ax. 45 | + .75 | + 2.75 cyl. ax. 82 |
| + 3.50 cyl. ax. 90 | + 1 cyl. ax. 60 | + .62 | + 3.25 cyl. ax. 51 |
| + 3.50 cyl. ax. 90 | + 1 cyl. ax. 75 | + .50 | + 3.50 cyl. ax. 71 |
| + 1 cyl. ax. 90 | + 1 cyl. ax. 60 | + .25 | + 4. cyl. ax. 51 |
| + 1 cyl. ax. 90 | + 4 cyl. ax. 75 | | + 4.50 cyl. ax. 87 |
| + 1 cyl. ax. 90 | + 1 cyl. ax. 15 | + .87 | + 3.25 cyl. ax. 20 |
| + 1 cyl. ax. 90 | + 4 cyl. ax. 25 | + .75 | + 3.50 cyl. ax. 31 |
| + 1 cyl. ax. 90 | + 4 cyl. ax. 35 | + .62 | + 3.75 cyl. ax. 42 |
| + 1 cyl. ax. 90 | + 2.50 cyl. ax. 45 | + .50 | + 4. cyl. ax. 52 |

## Dr. Wallace's Table for Reducing Crossed Cylinder Lenses to a Sphero-Cylindrical Combination.

*(Continued.)*

| Cylinder | | Cylinder | | Spherical | | Cylinder | | Cylinder | | Cylinder | | Spherical | | Cylinder | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 cyl. ax. 90 | + | 4 cyl. ax. 55 | + | .25 | + | 4.50 cyl. ax. 61 | + | 1 cyl. ax. 90 | + | 6.00 cyl. ax. 45 | + | .50 | + | 6. cyl. ax. 50 | + |
| 1 cyl. ax. 90 | + | 4 cyl. ax. 65 | + | .12 | + | 4.75 cyl. ax. 70 | + | 1 cyl. ax. 90 | + | 6.00 cyl. ax. 55 | + | .25 | + | 6.50 cyl. ax. 30 | + |
| 1 cyl. ax. 90 | + | 4 cyl. ax. 75 | + | | | 5 cyl. ax. 79 | + | 1 cyl. ax. 90 | + | 6.00 cyl. ax. 65 | + | .12 | + | 6.75 cyl. ax. 68 | + |
| 1 cyl. ax. 90 | + | 4.50 cyl. ax. 15 | + | .87 | + | 3.75 cyl. ax. 19 | + | 1 cyl. ax. 90 | + | 2 cyl. ax. 75 | + | | | 7. cyl. ax. 77 | + |
| 1 cyl. ax. 90 | + | 4.50 cyl. ax. 25 | + | .75 | + | 4. cyl. ax. 29 | + | 1.50 cyl. ax. 90 | + | 2 cyl. ax. 15 | + | 1.25 | + | 1. cyl. ax. 41 | + |
| 1 cyl. ax. 90 | + | 4.50 cyl. ax. 35 | + | .62 | + | 4.25 cyl. ax. 41 | + | 1.50 cyl. ax. 90 | + | 2 cyl. ax. 30 | + | .87 | + | 1.75 cyl. ax. 53 | + |
| 1 cyl. ax. 90 | + | 4.50 cyl. ax. 45 | + | .50 | + | 4.50 cyl. ax. 51 | + | 1.50 cyl. ax. 90 | + | 2 cyl. ax. 45 | + | .50 | + | 2.50 cyl. ax. 63 | + |
| 1 cyl. ax. 90 | + | 4.50 cyl. ax. 55 | + | .25 | + | 5. cyl. ax. 60 | + | 1.50 cyl. ax. 90 | + | 2 cyl. ax. 60 | + | .25 | + | 3. cyl. ax. 73 | + |
| 1 cyl. ax. 90 | + | 4.50 cyl. ax. 65 | + | .12 | + | 5.25 cyl. ax. 69 | + | 1.50 cyl. ax. 90 | + | 2 cyl. ax. 75 | + | | | 3.50 cyl. ax. 87 | + |
| 1 cyl. ax. 90 | + | 4.50 cyl. ax. 75 | + | | | 5.50 cyl. ax. 78 | + | 1.50 cyl. ax. 90 | + | 4 cyl. ax. 15 | + | 1.37 | + | 2.75 cyl. ax. 15 | + |
| 1 cyl. ax. 90 | + | 5 cyl. ax. 15 | + | .87 | + | 4.25 cyl. ax. 18 | + | 1.50 cyl. ax. 90 | + | 4 cyl. ax. 30 | + | 1.00 | + | 3.50 cyl. ax. 11 | + |
| 1 cyl. ax. 90 | + | 5 cyl. ax. 25 | + | .75 | + | 4.50 cyl. ax. 30 | + | 1.50 cyl. ax. 90 | + | 4 cyl. ax. 45 | + | .62 | + | 1.25 cyl. ax. 55 | + |
| 1 cyl. ax. 90 | + | 5 cyl. ax. 35 | + | .62 | + | 4.75 cyl. ax. 41 | + | 1.50 cyl. ax. 90 | + | 4 cyl. ax. 60 | + | .25 | + | 6. cyl. ax. 68 | + |
| 1 cyl. ax. 90 | + | 5 cyl. ax. 45 | + | .50 | + | 5. cyl. ax. 51 | + | 1.50 cyl. ax. 90 | + | 4 cyl. ax. 75 | + | | | 5.50 cyl. ax. 79 | + |
| 1 cyl. ax. 90 | + | 5 cyl. ax. 55 | + | .25 | + | 5.50 cyl. ax. 60 | + | 3 cyl. ax. 90 | + | 5 cyl. ax. 15 | + | 2.50 | + | 3. cyl. ax. 32 | + |
| 1 cyl. ax. 90 | + | 5 cyl. ax. 65 | + | .12 | + | 5.75 cyl. ax. 69 | + | 3 cyl. ax. 90 | + | 5 cyl. ax. 30 | + | 1.75 | + | 4.50 cyl. ax. 48 | + |
| 1 cyl. ax. 90 | + | 5.50 cyl. ax. 15 | + | .87 | + | 6. cyl. ax. 77 | + | 3 cyl. ax. 90 | + | 5 cyl. ax. 45 | + | 1.00 | + | 6. cyl. ax. 60 | + |
| 1 cyl. ax. 90 | + | 5.50 cyl. ax. 25 | + | .75 | + | 4.75 cyl. ax. 18 | + | 3 cyl. ax. 90 | + | 5 cyl. ax. 60 | + | .50 | + | 7. cyl. ax. 71 | + |
| 1 cyl. ax. 90 | + | 5.50 cyl. ax. 35 | + | .62 | + | 5. cyl. ax. 29 | + | 3 cyl. ax. 90 | + | 7 cyl. ax. 15 | + | .12 | + | 7.75 cyl. ax. 81 | + |
| 1 cyl. ax. 90 | + | 5.50 cyl. ax. 45 | + | .50 | + | 5.25 cyl. ax. 40 | + | 3 cyl. ax. 90 | + | 7 cyl. ax. 25 | + | 2.75 | + | 4.75 cyl. ax. 25 | + |
| 1 cyl. ax. 90 | + | 5.50 cyl. ax. 55 | + | .25 | + | 5.50 cyl. ax. 50 | + | 3 cyl. ax. 90 | + | 7 cyl. ax. 35 | + | 2.25 | + | 5.50 cyl. ax. 37 | + |
| 1 cyl. ax. 90 | + | 5.50 cyl. ax. 65 | + | .12 | + | 6. cyl. ax. 60 | + | 3 cyl. ax. 90 | + | 7 cyl. ax. 45 | + | 1.75 | + | 6.75 cyl. ax. 18 | + |
| 1 cyl. ax. 90 | + | 6.00 cyl. ax. 15 | + | .87 | + | 6.25 cyl. ax. 69 | + | 3 cyl. ax. 90 | + | 7 cyl. ax. 55 | + | 1.25 | + | 7.75 cyl. ax. 57 | + |
| 1 cyl. ax. 90 | + | 6.00 cyl. ax. 25 | + | .75 | + | 6.50 cyl. ax. 78 | + | 3 cyl. ax. 90 | + | 7 cyl. ax. 65 | + | .75 | + | 8.50 cyl. ax. 65 | + |
| 1 cyl. ax. 90 | + | 6.00 cyl. ax. 35 | + | .62 | + | 5.25 cyl. ax. 18 | + | 3 cyl. ax. 90 | + | 7 cyl. ax. 75 | + | .37 | + | 9.50 cyl. ax. 73 | + |
| | | | | | | 5.75 cyl. ax. 40 | + | | | | | .12 | + | 10 cyl. ax. 81 | + |

(49)

PUBLISHED BY FERGUSON & WESTON.

| Cylinder | Spherical | Cylinder | Cylinder | | Cylinder | Spherical | Cylinder | Cylinder |
|---|---|---|---|---|---|---|---|---|

(50)

| Cylinder | Cylinder | Spherical | Cylinder |
|---|---|---|---|
| 1 cyl. ax. 90 | — 5.50 cyl. ax. 40 | + .62 | — 5.75 cyl. ax. 35 |
| 1 cyl. ax. 90 | — 5.50 cyl. ax. 50 | + .50 | — 5.50 cyl. ax. 45 |
| 1 cyl. ax. 90 | — 5.50 cyl. ax. 60 | + .25 | — 5. cyl. ax. 55 |
| 1 cyl. ax. 90 | — 5.50 cyl. ax. 70 | + .12 | — 4.75 cyl. ax. 66 |
| 1 cyl. ax. 90 | — 5.50 cyl. ax. 80 | — | — 4.40 cyl. ax. 78 |
| 1 cyl. ax. 90 | — 6 cyl. ax. 10 | — 1. | — 7. cyl. ax. 9 |
| 1 cyl. ax. 90 | — 6 cyl. ax. 20 | + .87 | — 6.75 cyl. ax. 17 |
| 1 cyl. ax. 90 | — 6 cyl. ax. 30 | + .75 | — 6.50 cyl. ax. 26 |
| 1 cyl. ax. 90 | — 6 cyl. ax. 40 | + .62 | — 6.25 cyl. ax. 36 |
| 1 cyl. ax. 90 | — 6 cyl. ax. 50 | + .50 | — 6. cyl. ax. 45 |
| 1 cyl. ax. 90 | — 6 cyl. ax. 60 | + .25 | — 5.50 cyl. ax. 55 |
| 1 cyl. ax. 90 | — 6 cyl. ax. 70 | + .12 | — 5.25 cyl. ax. 67 |
| 1 cyl. ax. 90 | — 6 cyl. ax. 90 | — | — 5. cyl. ax. 78 |
| 3 cyl. ax. 90 | — 4 cyl. ax. 10 | — 3. | — 7. cyl. ax. 6 |
| 3 cyl. ax. 90 | — 4 cyl. ax. 20 | + 2.75 | — 6.50 cyl. ax. 12 |
| 3 cyl. ax. 90 | — 4 cyl. ax. 30 | + 2.50 | — 6. cyl. ax. 17 |
| 3 cyl. ax. 90 | — 4 cyl. ax. 40 | + 2.25 | — 5.50 cyl. ax. 23 |
| 3 cyl. ax. 90 | — 4 cyl. ax. 50 | + 1.75 | — 4.50 cyl. ax. 30 |
| 3 cyl. ax. 90 | — 4 cyl. ax. 60 | + 1.25 | — 3.50 cyl. ax. 37 |
| 3 cyl. ax. 90 | — 4 cyl. ax. 70 | + .75 | — 2.50 cyl. ax. 46 |
| 3 cyl. ax. 90 | — 4 cyl. ax. 80 | + .25 | — 1.50 cyl. ax. 59 |
| 3 cyl. ax. 90 | — 5 cyl. ax. 10 | — 3. | — 8. cyl. ax. 6 |
| 3 cyl. ax. 90 | — 5 cyl. ax. 20 | + 2.75 | — 7.50 cyl. ax. 13 |

| Cylinder | Cylinder | Spherical | Cylinder |
|---|---|---|---|
| 3 cyl. ax. 90 | — 5 cyl. ax. 30 | + 2.50 | — 7. cyl. ax. 19 |
| 3 cyl. ax. 90 | — 5 cyl. ax. 40 | + 2.25 | — 6.50 cyl. ax. 26 |
| 3 cyl. ax. 90 | — 5 cyl. ax. 50 | + 1.50 | — 5.75 cyl. ax. 33 |
| 3 cyl. ax. 90 | — 5 cyl. ax. 60 | + .50 | — 5.75 cyl. ax. 43 |
| 3 cyl. ax. 90 | — 5 cyl. ax. 70 | — | — 3.75 cyl. ax. 58 |
| 3 cyl. ax. 90 | — 7 cyl. ax. 10 | — 3. | — 2.50 cyl. ax. 67 |
| 3 cyl. ax. 90 | — 7 cyl. ax. 20 | + 2.75 | — 10. cyl. ax. 7 |
| 3 cyl. ax. 90 | — 7 cyl. ax. 30 | + 2.50 | — 9.50 cyl. ax. 14 |
| 3 cyl. ax. 90 | — 7 cyl. ax. 40 | + 2. | — 9. cyl. ax. 22 |
| 3 cyl. ax. 90 | — 7 cyl. ax. 50 | + 1.50 | — 8. cyl. ax. 29 |
| 3 cyl. ax. 90 | — 7 cyl. ax. 60 | + 1. | — 7. cyl. ax. 38 |
| 3 cyl. ax. 90 | — 7 cyl. ax. 70 | + .50 | — 6. cyl. ax. 46 |
| 3 cyl. ax. 90 | — 7 cyl. ax. 80 | + .12 | — 5. cyl. ax. 59 |
| 3 cyl. ax. 90 | — 8 cyl. ax. 10 | — 3. | — 11. cyl. ax. 72 |
| 3 cyl. ax. 90 | — 8 cyl. ax. 20 | + 2.75 | — 10.50 cyl. ax. 15 |
| 3 cyl. ax. 90 | — 8 cyl. ax. 30 | + 2.50 | — 10. cyl. ax. 22 |
| 3 cyl. ax. 90 | — 8 cyl. ax. 10 | — | — 9.50 cyl. ax. 30 |
| 3 cyl. ax. 90 | — 8 cyl. ax. 30 | + 1.50 | — 8. cyl. ax. 39 |
| 3 cyl. ax. 90 | — 8 cyl. ax. 60 | + 1. | — 8. cyl. ax. 49 |
| 3 cyl. ax. 90 | — 8 cyl. ax. 70 | + .50 | — 7. cyl. ax. 61 |
| 3 cyl. ax. 90 | — 8 cyl. ax. 80 | + .12 | — 6. cyl. ax. 74 |
| | | | — 5.25 cyl. ax. 74 |

## Dr. Wallace's Table for Reducing Crossed Cylinders to a Sphero-Cylindrical Combination.

RULE 4.—The formula for two concave cylinders is the same as that for two convex cylinders, with minus signs instead of plus.

RULE 5.—When the convex and concave cylinders are crossed, the resultant spherical has the sign of the weaker cylinder ( + or — ) the resultant cylinder the sign of the stronger cylinder, and the axis is reversed 90°. Ex., +1 cy 90 —2 cy. 20 = +.87 —2.75ax. 13, +2 cyl. ax. 90 —1 ax. 20 = —.87 = 2.75ax. 10 z. It is unnecessary to work out more than a single series of one ratio as +1 with 1.50; +2 with —3; +.50 with —.75 will have the same angle in the resultant cylinder, and the spherical and cylinder of the second will be twice that of the first. The spherical and cylinder of the third will be one-half that of the first. This table combined with the rules given above will enable one to work out any combination with accuracy. In the preparation of the table the absolute refractive value of each meridian has been calculated from the elliptical curves of the rotating cylinders.

# Toric Lenses; or Periscopic Cylindrical and Sphero-Cylindrical Glasses,

—BY—

## DR. GEORGE C. HARLAN.

At a meeting of the American Ophthalmological Society, in July, 1885, I gave a description of a sphero-cylindrical lens ground on one surface only, and explained the method of its manufacture. The superiority of the periscopic form of lens, or meniscus, when high powers are required, is, I believe, universally admitted, and its use is quite general in the case of spherical glasses. This has not been the case, however, with cylinders and sphero-cylinders, as opticians generally have not undertaken to grind them in this form. The lens to which I wish again to call the attention of this Society consists of crossed cylinders ground on one surface of the glass, the other side being left for any desired spherical curve. In this way a meniscus may be produced. Here, for instance, is a combination lens giving the effect of $+ 4. \supset + 2.$ cyl. To produce this effect crossed cylinders of 4 and 6 are required, supposing the other side to be left plain. If we wish to give the periscopic form to this glass, it can be done by making the cylinders 6 and 8 and grinding a $- 2$ spherical on the other surface. If a simple cylinder is needed, the spherical curve must equal that of the weaker cylinder.

NOTE.—Dr. Wallace's table resolves all crossed cylinders with oblique axes into a sphero-cylindrical combination, or in other words, places the principal meridians at right angles to each other. This will be found very useful in preparing a formula for toric lenses combined with bifocal segments.

# NOTES ON RETINOSCOPY,

BY

## Dr. James Thorington.

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1.—THE PRINCIPLE OF RETINOSCOPY is the finding of the point of reversal, the point where the emergent rays of light, from the eye under examination, come to a focus, or are made to come to a focus, by placing a lens in front of it.

2.—THE ROOM must be darkened, the darker the better,—all sources of light except the one in use to be excluded.

3.—THE OBSERVER need not make any note of his accommodation as in using the ophthalmoscope, but as he requires very acute vision, he should wear any necessary correcting glasses.

4.—THE PATIENT must have his accommodation thoroughly relaxed with a reliable cycloplegic.

5.—THE DISTANCE of the patient from the observer is usually one meter, and this distance will be considered in the following statements.

6.—THE DIRECTION of the movement of the retinal illumination as seen in the center of the pupillary area, is a most important point in the study of retinoscopy.

7.—THE PLANE MIRROR shows the retinal illumination moving *with* the movement of the mirror in emmetropia, hyperopia, or myopia, if the myopia be less than one diopter, and the illumination moving *opposite* to the movement of the plane mirror when the myopia is more than one diopter.

8.—THE POINT OF REVERSAL for the center of the pupillary area is found when a lens (or a series of lenses) placed in front of the eye under examination, stops all apparent movement of the illumination in this area.

9.—A PLUS LENS is required to stop the apparent movement of the illumination, (at one meter) in emmetropia, hyperopia, and myopia of less than one diopter.

10.—A MINUS LENS is required to stop all apparent movement of the illumination (at one meter) in myopia of more than one diopter.

11.—THE MERIDIAN is being refracted through which the observer passes the light.

12.—ASTIGMATISM is recognized when the illumination appears to move faster in one meridian than the meridian at right angles to it, the astigmatism will be in the meridian of slow movement.

ASTIGMATISM is also recognized by the presence of a band of light extending across the pupil; this may not appear until a spheric lens has been placed before the eye.

13.—RULES FOR LENSES at one meter.

Add a minus 1. D. sphere to the result obtained in the dark room in every instance and the result will be the emmetropic or infinity correction.

14.—All retinoscopic work should, when possible, be confirmed at the trial case before ordering the patient's glasses.

15.—RETINOSCOPY is the most exact objective method of estimating the refraction of an eye that there is and it is the most satisfactory, when carefully executed.

# Subjective and Objective Methods of Measuring Refractive Errors.

## By JOHN T. CARPENTER, JR.

All methods for the estimation of the amount of refractive errors are based upon a knowledge of the *static* refraction of the dioptric system of the eye. The employment of a satisfactory cycloplegic is therefore a *sine qua non*. After the age of 55 this is often unnecessary. Methods for the measurement of errors of refraction may be classed as Subjective and Objective. In the Subjective method, we depend upon our patient's replies and determine the refractive error by means of suitable test-letters.

Normal visual acuity exists when letters, subtending a visual angle of 5′, with the component parts of the letter subtending a visual angle of 1′, are recognized by the patient who is placed at a convenient distance from the test card. Upon this basis of normal visual acuity are constructed the test types of Snellen and those of his many imitators.

Letters are placed at 6 meters, as rays may then be regarded as practically parallel.

In expressing visual acuity, we place the distance at which the patient is stationed as the numerator, and the distance at which the test-letter subtends a visual angle of 5′ as the denominator of the fraction. Thus : 6-24 would mean that the patient stationed at 6 meters, read test-letters which should have been distinguished at 24 meters.

## PROCEDURE IN SUBJECTIVE OPTOMETRY.

Hyoscyamin, Duboisin, Atropin or some reliable cycloplegic, must be instilled until complete paralysis of the ciliary muscle has been gained. The visual acuity of each eye (the other being open, but excluded from vision) must then be ascertained and recorded. Healthy emmetropic eyes, with accommodative power completely paralyzed, should possess visual acuity = 6/6.

Convex sphericals are next placed before the eye, and improvement in vision demonstrates the existence of hyperopia, as convergent rays produced by convex lenses are only brought to a focus in the short eye-ball of the hyperope.

Convex spherical lenses of increasing power are introduced until visual acuity reaches its maximum and any stronger lens causes deterioration in vision. To the spherical glass producing maximum visual acuity, cylinders are now added, at first with their axes vertical, and the strongest cylinder which causes the greatest improvement in visual acuity is the measure of the astigmatism present. By rotating the cylinder 5 or 10 degrees to right or left, sharper visual acuity may sometimes be gained at one particular spot which determines the axis of the astigmatism. A complete rotation of the cylinder may be necessary in order to determine its proper axis.

The final result is then reached by carefully testing the increase or decrease of the combined sphero-cylinder by weak convex and concave spherical and cylindrical lenses or crossed cylinders.

The same procedure is adopted in Myopia ; being careful to note the *weakest* concave lens producing maximum visual acuity. When much astigmatism exists, this test is supplemented by a very valuable procedure, namely : testing the visual acuity for lines drawn at right angles to each other. These are made up of 3 parallel lines of exactly equal intensity and width.
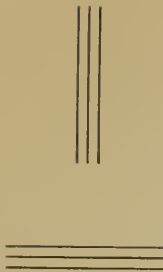
The lines are printed on circular disks, which can be rotated so as to stand in any meridian. By having the patient fix his attention first upon one set of lines and placing stronger and stronger spherical lenses before the eye until these lines become sharply defined; and next proceeding in the same manner with the parallel lines placed at right angles, the result gives the correct measurement of the refraction in each of the principal meridians of the astigmatic eye. The glass can then be calculated easily.

Example: Lines at 90° ||| are most distinctly seen with + 2.50 spherical, while lines at 180° ≡ are best seen with + 3.50 spherical. Remembering that the lines measure the meridian at right angles to their direction, the formula for the proper correcting glass would be + 2.50 sph. ○ + 1.00 cyl. ax. 180°.

Of great service is also the stenopaic slit, by means of which different meridians can be measured separately, and the combined lens found correcting the two principal meridians. Scheiner's perforated disk, as brought forward by Thomson, the Cobalt glass, giving chromatic test; and in short, every means in our power may be needed in order to correctly solve puzzling cases. Rapid work usually means careless work.

## OBJECTIVE TESTS

*1st* and most important, I should place Retinoscopy, as giving the entire amount of refractive error, whether Hyperopia, Myopia, or Astigmatism.

*2d.* Direct method of Ophthalmoscope, in which a fine vascular twig in the central portion of the fundus is used, upon which to focus. It is important to remember that the *strongest convex* and *weakest concave* lens is the measure of the Hyperopia or Myopia present in the meridian at right angles to the direction of this fine retinal vessel.

*3d.* Ophthalmometer for detection of corneal astigmatism.

Objective tests, in my opinion, are valuable as time savers, and as giving reliable information independent of the "personal equation" of the patient at least, (if not of the ophthalmic surgeon making the test). No objective test can supplant the more tedious but more practical subjective methods, and if I were compelled to adopt *one* method it would be that of subjective optometry with test-lenses.

The most satisfactory routine in the measurement of refractive errors I believe to be the following :

1. Testing visual acuity at 6 meters.
2. Testing punctum proximum and punctum remotum with small type.
3. Testing muscular balance at 6 meters, and in accommodation at 33 ctm.
4. Ophthalmoscope—Direct method.
5. Ophthalmometer for Corneal Astigmatism.
6. Retinoscopy and the Direct Method of Ophthalmoscope, to be used after instillation of a Cycloplegic, preferably Hyoscyamin Sulphate, gr. ¼—ℨi or Duboisin Sulphate, gr. ¼—ℨi. This gives the total error present, whether Hyperopia, Myopia, or Astigmatism—both corneal and lenticular. This correction should serve as a basis from which to try, in the careful and methodical manner, above described, the subjective method with test-lenses in the trial case.

For final proof the sphero-cylindrical correction should be proved by Retinoscopy.

# The Detection of Simulated Monocular Blindness.

## By DR. WM. CAMPBELL POSEY.

It is at times necessary to be able to prove that vision, which is claimed to be lost or extremely defective in one eye, is really good. This happens in the army when recruits demand exemption from service on the plea of bad sight, in medico-legal cases, when damages are sued for upon account of professed loss of sight from injury, and in hysteria.

As the individuals making this claim are intelligent and oftentimes familiarize themselves with many of the tests used for the detection of their simulation, it is necessary that the examiner should have a variety of procedures at his command, with which he is perfectly familiar, to outwit them, and to show conclusively that the organ which they would have rated below the standard, is actually a useful member, possessing a satisfactory degree of acuity.

In the performance of the tests, it is always wise to give the person under examination the impression that his tale is believed, and that the procedures which are being carried out are simply for the purpose of ascertaining the condition and the degree of visual acuity in the sound eye. Although there are many devices for the detection of malingering, but three of the more valuable will be detailed here.

### THE PRISM TEST.

The subject is seated before a lighted candle, and a prism of eight degrees, base up or down having been placed before the sound eye, he is requested to regard the flame at five meters distance. If double images are acknowledged, the proof of his simulation is accomplished, for one of the images must belong to the supposedly defective eye.

This test has been modified by Al. von Graefe in a most ingenious manner. The sound eye is made to see double by holding the apex of a prism before half of its pupil. One image is thus obtained through the unobstructed half of the pupil, and the second through the other half by the deflection of the rays by the prism. The patient should at once, without hesitation, acknowledge seeing double images. The edge of the prism is then raised or depressed sufficiently to cover the entire pupil, so that but one image is perceived by the sound eye, although on a different vertical plane. If the patient now sees double, there is conclusive proof that the avowed defective eye must be acting, and the fraud is detected.

If the ordinary Snellen type be substituted for the candle flame, it is possible to obtain the degree of visual acuity in the pretended bad eye by producing double images of the different lines on the chart in the same manner as in the candle test.

As the bringing of the apex of the prism before but a part of the pupil is always attended with some difficulty, and the patient apt to become cognizant of what is be-

ing attempted, Baudry has recently introduced a device by means of which these diffi-culties are entirely overcome. He employs a triangular prism, a section of a right angled triangle, and uses the base of the prism to deflect the light instead of its apex. This prism is divided into two parts by horizontal sections and cemented at their bases to the centres of the parallel aspects of the same thicknesses.

In its entirety, the lens represents a fragment of polished glass divided into three distinct parts in juxtaposition to one another by their ground surfaces.

The prism is contained in a round metallic box, with central apertures in each of its surfaces. By means of a simple mechanism it is possible to bring the bodies of the prismatic sectors or their bases before the sound eye, and single or double vision obtained at will, without the possibility of the subject being cognizant what portion of the prism he is looking through.

To avoid the difference in tint between the true image and the virtual one pro-duced by the passage of the rays through the prism, a red glass is placed before the candle flame. This serves to neutralize the decomposition of light produced by the prism and makes the real and virtual images identical.

## HARLAN'S TEST.

By this method, the sound eye is secretly excluded by placing a lens of such high degree before it, that its far point falls within a few inches of the eye, whilst a lens of such weak power is placed before the pretended defective eye, that its visual acuity is not interfered with. Practically, the refraction of both eyes having been ascertained by the ophthalmoscope, the subject is seated five meters away from the ordinary test charts. Whilst both eyes are open, a high convex spherical lens (plus sixteen diopters) is slipped into a trial frame before the sound eye and a lens which about corrects the refraction of the bad eye is placed before it. If any of the letters on the chart are now read, this must have been accomplished by the avowed defective eye, as the vision in the sound eye had been excluded by the high spherical lens.

An effort should now be made to convince the patient of the degree of the visual acuity in his supposedly defective eye by asking him to read with the lens still in posi-tion, but with his bad eye closed.

## SNELLEN'S TEST.

In the application of this test, Snellen has taken advantage of the law of comple-mentary colors, employing a test card with alternate red and green letters. The patient is seated before the card and told to regard the chart through a pair of spectacles which are so constructed that a red glass is placed before one eye and a green one before the other. The eye looking through the red glass can only perceive the red letters, as green is the complementary color of red, while the eye looking through the green glass can only see the green letters for the same reason.

If a man who is blind in one eye looks at this chart through these glasses, he will see only the red or the green letters according as the red or green glass is before the sound eye. If both red and green letters are read, then it is obvious that both eyes are functioning.

# AN ADJUSTABLE LAMP OR LIGHT SCREEN.

## ESPECIALLY ADAPTED TO THE SHADOW TEST.

**Designed by DR. M. W. ZIMMERMAN.**

To obtain the best results in examination of the eye by artificial light, it is essential that the size and shape of the light source shall be easily adjustable, and general illumination of the room reduced to the minimum. This is peculiarly true of the modern and more exact methods of applying the shadow test, in which accuracy depends very largely upon the reduction in the area of both light and mirror surface.

The illustrations show a device which meets all the requirements *out-lined* above. The main vertical barrel of the screen is made of asbestos, and completely covers the glass chimney, and is furnished inside with springs, which clasp the latter gently, holding it in position.

The lateral openings are arranged so as to be present opposite the greatest illuminating power. On one side, four circular openings, respectively, 5, 7½, 10 and 25 millimeters in diameter, have been arranged in a revolving disc which is accurately halted at the desired point by a spring clip. These fulfill all possible requirements of skiascopy, while the largest is quite sufficient for most ophthalmoscopic work.

Directly opposite the above openings is one which exposes practically the entire flame, while its projecting border prevents needless radiation of light. Two shutters are hinged to fit over this opening, one being blank to prevent the escape of light when using the opposite side, while the other is fenestrated and backed by a sheet of thin porcelain glass. The latter plan secures a clear white illuminated image corresponding to the opening in the metal, and one which, owing to the absence of marked diffusion at its margin, forms a most satisfactory object for distant muscle testing. For this purpose we have adopted the simple Greek cross as suggested by Dr. Ziegler, but smaller, and find it satisfactory. The diameter of the arms is 10 millimeters, and the total diameter of the cross is 50 millimeters.

This lamp screen can be used with either the Welsbach or Argand gas burner. Price, $3.50.

## FERGUSON & WESTON, Opticians,

**Chestnut and 15th Sts.,    =    =    Philadelphia, Pa.**

# The Ophthalmometer and its Clinical Use.

## By DR. E. W. STEVENS.

The Ophthalmometer of Javal and Schiotz, consists of a telescope mounted upon a tripod, which can be moved laterally, or backward or forward to obtain the proper focus. By means of an elevating screw, attached to one foot of the tripod, the telescope is adjusted for the level of the observed eye. The telescope contains a double refracting prism between two convex lenses. The eye to be measured is placed at the principal focus of the first lens. At the principal focus of the second lens there is formed an inverted image of the erect image, formed by reflection on the cornea. At this point there is spider line sight for which the eye piece of the instrument is focused.

A graduated arc is fixed upon the tube of the telescope so as to rotate with the tube about its axis. This arc is provided with a long pointer, which indicates upon the large disk of the instrument, the number of degrees the arc and telescope have been rotated.

To this graduated arc is also attached two white enameled sights or mires mounted on a background of black velvet. One mire, a right angled parallelogram in shape, is clamped at 20° on the arc. The other mire is cut in a series of steps, each of which is calculated to represent one dioptre of corneal refraction, or a power equal to a cylinder of one dioptre. This stepped mire is arranged to slide upon the graduated arc. When properly adjusted, the images of the mires, doubled by the prism in the telescope, are seen reflected on the cornea of the observed eye, as shown in (Fig. 2).
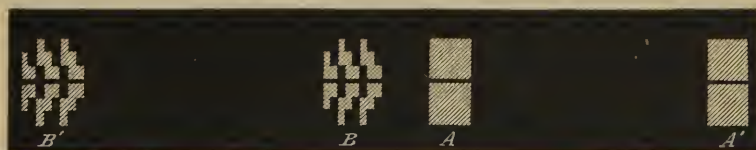


FIG. 2.

A large disk, upon the periphery of which degrees are painted in inverted characters, numbered from 0° to 180°, stands just behind the arc which carries the mires. These numerals appear erect and in correct position when reversed by reflection on the cornea, and viewed through the inverting telescope. The special purpose of the large disk is to enable the observer to read the degrees of the meridians of greatest and least curvature directly from the reflection on the cornea. To this end each mire is furnished with a short white pointer.

The large disk and pointers had no place in the original model of the Ophthalmometer, the meridians of greatest and least curvature being read from a stationary graduated circle facing the observer, just back of the graduated arc. An index moving on this circle gave the position of the axes. In some modern instruments this same mechanism has been adopted.

## HOW TO VERIFY THE INSTRUMENT.

To students beginning the use of the Ophthalmometer, as well as to those who wish to verify the exactness of their instrument, the artificial astigmatic cornea will be of great service. This cornea is made of polished metal and mounted on a small disk, so as to rotate within a graduated circle. An arrow engraved on the movable disk points out the meridian of greatest curvature.

The known value of the astigmatism of the artificial cornea affords the means of controlling the accuracy of the measurement.

**The use of the Ophthalmometer** requires a close attention to detail, and a rapid execution of several operations which can only be acquired by practice.

The first requisite is a good light, which must be behind the patient, so that the disk and mires are fully illuminated. The examiner should first adjust the telescope by rotating the ocular until the cross-lines are brought clearly into view. The ocular should then be turned slowly to the left, so as to draw it out to the greatest extent compatible with seeing the cross lines sharply defined. The telescope should be turned so that the long pointer is below and at zero.

The patient is now seated before the instrument in an easy position, with his chin resting on the chin rest, and his forehead pressed against the forehead rest. His eyes should be widely open and *exactly on the same level*. This position is indispensable for ascertaining the precise axes of the principal meridians. One eye is now covered by the small shade, and the observer sights along the telescope through the notch above it at the patient's eyebrow. Then sighting through the tube, he moves the instrument forward or backward, and raises or lowers it by the thumb screw until the eye is brought into the field of the telescope, and a distinct image of the mires and disk is seen on the cornea. We now see pictured upon the cornea of the observed eye two overlap-
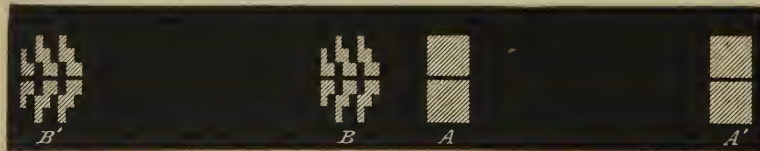
FIG. 2.

ping images of the large disk. In the oval space thus formed are seen the two mires, to which we confine our attention. The observer now slides the mire at his right along the arc until its reflection touches the reflection of the stationary mire, and notes whether the two guide-lines which bisect the mires are in a continuous line. When the eye under examination is astigmatic, we see that in certain positions of the arc these guide-lines do not lie in a continuous line. To bring them into line we rotate the telescope so that the long pointer moves from 0° toward 135°. If the lines do not become continuous when 135° is reached, the rotation proceeds no further in this direction, but the pointer is turned back to 0°, and then toward 45°, but never beyond 45°. With regular astigmatism the lines always become continuous within 45° of the zero. When we bring them into line, we move the slipped mire along the arc until its image is seen exactly in contact with that of the other mire (Fig. 2).

The instrument should now be carefully focused, and in doing this it should be drawn as far away from the observed eye as possible without impairing the definition of the mires. The double image of the disk, which lies in a plane a little behind the mires, will then appear slightly blurred. Having noted the angle marked by the long pointer, we next rotate the telescope with its arc 90°. In executing this movement, it is generally best to rotate from left to right, so that the stepped mire can always be reached through one of the openings in the disk.

If the images of the mires now overlap (Fig. 3) for example, two steps in this second position, with the long pointer at 80°, there is astigmatism of two dioptres with the rule, and is recorded 2.00 D. cyl. ax. 80°, as (Fig. 3).



FIG. 3.

If on the other hand, the images of the mires in the second position, instead of overlapping, are seen to recede from each other, there is astigmatism against the rule. In this case, in order to ascertain the exact number of steps or dioptres to which the separation of the mires is equivalent, they are approximated by moving the sliding mire until the reflections touch, and the telescope is then rotated back to the primary position. The mires will now overlap and the amount of astigmatism can be read off just as in astigmatism with the rule.

The upper surface of the arc carrying the mires is graduated to show dioptres of refraction. It does not measure the Hypermetropia or Myopia of the eye, but indicates the corneal curvature. The total refraction of at least one corneal meridian should be given, and preferably, the one of least refraction. The rectangular mire being clamped at 20°, we obtain the required value in dioptres for the meridian for which the arc is set by adding 20° to the reading of the stepped mire. For example, if we find in the right eye one dioptre of astigmatism with the rule, at 75°, and the right hand mire at 23° on the arc, the refraction may be recorded O. D. 43.00 D = D. cyl. ax. 75 with the rule.

If so desired, the astigmatism can be read from the graduated arc, by bringing the images of the mires into exact contact in both principal meridians.

At times the Ophthalmometer indicates that the principal meridians of the cornea are not at right angles to each other. Thus one meridian may be at 180° and the other at 80°, in this case, both numbers should be noted, and where there is Hypermetropia the axis of the cylinder will be 80°, and when there is Myopia, 180°.

## CLINICAL VALUE.

The Ophthalmometer measures only the astigmatism of the anterior surface of the cornea, and this differs from the total subjective astigmatism of the eye in so far as the former is affected by *a*, astigmatism of the posterior surface of the cornea, and *b*, lental astigmatism. Moreover, the Ophthalmometer reading assumes for the correcting cylin-

drical glass a position in actual contact with the cornea, and in the higher grades of astigmatism, the distance from the cornea, at which the glass is worn, must be taken into account.

According to Bull and Cibret, the value of the astigmatism of the posterior surface of the cornea is —0.75 D. In fact, when we measure an eye, which, even under a mydriatic shows no subjective astigmatism, the Ophthalmometer usually records a corneal astigmatism of 0.50 D. to 0.75 according to the rule. On the other hand, when the instrument shows no astigmatism of the anterior surface of the cornea, there is generally found a subjective astigmatism of 0.75 D. or 0.50 D. against the rule. The normal emetropic eye, therefore, seems to show a slight astigmatism with the rule, of the anterior surface of the cornea, and this is neutralized by an internal astigmatism of the same grade against the rule. Numerous observations, however, have shown that this internal astigmatism, while on the average equal to —0.75 D., may be either greater or less than this by one dioptre. In this case, we have probably another factor, viz : astigmatism of the lens.

Of lental astigmatism, like that of the posterior surface of the cornea, we know little or nothing, since we only assume it to be present when we find a marked difference between the total subjective astigmatism and that of the anterior surface of the cornea.

It is not possible, therefore, at the present time, to lay down any empirical formula by means of which the total astigmatism may be calculated from measurements of the corneal curvature as made by the Ophthalmometer. In many cases the total astigmatism differs but little from the corneal astigmatism, while in astigmatism against the rule and in high grades of direct astigmatism (over 3.00 D.) the total astigmatism is generally higher than that indicated by the Ophthalmometer.

| | Number of Lens in Dioptrics | Focal Distance in Millimetres | Focal Distance in Inches | Nearest Corresponding Lens in Old System |
|---|---|---|---|---|
| Interval of 0.12 D. . . | 0.12 | 8000 | 314.96 | . . . |
| | 0.25 | 4000 | 157.48 | 144 |
| | 0.37 | 2666 | 104.99 | 96 |
| | 0.50 | 2000 | 78.74 | 72 |
| | 0.62 | 1600 | 62.99 | 60 |
| | 0.75 | 1333 | 52.5 | 48 |
| | 0.87 | 1143 | 44.99 | 42 |
| | 1.00 | 1000 | 39.37 | 40 |
| | 1.12 | 888 | 34.99 | 36 |
| | 1.25 | 800 | 31.5 | 30 |
| Interval of 0.25 D. . . | 1.50 | 666 | 26.22 | 26 |
| | 1.75 | 571 | 22.48 | 22 |
| | 2.00 | 500 | 19.69 | 20 |
| | 2.25 | 444 | 17.48 | 18 |
| | 2.50 | 400 | 15.75 | 16 |
| | 2.75 | 363 | 14.31 | 15 or 14 |
| | 3.00 | 333 | 13.12 | 13 |
| | 3.25 | 308 | 12.11 | 12 |
| | 3.50 | 285 | 11.25 | 11 |
| | 3.75 | 266 | 10.49 | . . . |
| | 4.00 | 250 | 9.84 | 10 |
| | 4.25 | 235 | 9.26 | 9 |
| | 4.50 | 222 | 8.74 | . . . |
| | 4.75 | 210 | 8.29 | . . . |
| | 5.00 | 200 | 7.87 | 8 |
| Interval of 0.50 D. . . | 5.50 | 182 | 7.16 | 7 |
| | 6.00 | 166 | 6.54 | . . . |
| | 6.50 | 154 | 6.06 | 6 |
| | 7.00 | 143 | 5.63 | . . . |
| | 7.50 | 133 | 5.25 | . . . |
| | 8.00 | 125 | 4.92 | 5 |
| Interval of 1 D. . . . | 9.00 | 111 | 4.37 | 4.5 |
| | 10.00 | 100 | 3.94 | 4 |
| | 11.00 | 91 | 3.58 | 3.50 |
| | 12 | 83 | 3.27 | 3.25 |
| | 13 | 77 | 3.03 | 3 |
| | 14 | 71 | 2.8 | 2.75 |
| | 15 | 66 | 2.64 | . . . |
| | 16 | 62 | 2.44 | 2.5 |
| | 17 | 59 | 2.32 | . . . |
| | 18 | 55 | 2.17 | 2.25 |
| Interval of 2 D. . . . | 20 | 50 | 1.97 | 2 |
| | 22 | 45 | 1.79 | 1.75 |

In the old system the lenses are ground with a radius of curvature in Paris inches. The focal length is almost exactly the same number of English inches as the radius of curvature is of French inches.